...ULUM ELEMENTARY
1980 SCIENCE
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Alberta
EDUCATION

CONTENTS

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INTRODUCTION

Children live in a vast, interesting and expanding world of science and technology. New discoveries, new dimensions of human endeavor and new understandings replace the "facts" of yesterday. Our rapidly changing society produces new information faster than ever before. Such changes influence educational practices and in particular the approach to science education in the elementary school.

In the past, education has tended to focus on teaching facts to children. While this is a natural and obvious goal of education, it does not represent the total educational program. The development of proficiency in learning by using and understanding process skills is also an important aspect of science education. The process skills of science (e.g. to observe carefully, to collect pertinent data, to make logical inferences, etc.) are consistent with the learning skills which are necessary in each child's education. The science curriculum should, therefore, reflect the importance of process skills in its program and instruction.

Although instruction in learning processes is important, it should not be emphasized to the exclusion of science concepts. Data and scientific concepts are also necessary ingredients of an inquiry approach to science. Science is at one and the same time a body of knowledge and a process of inquiry. In addition, the learning of process skills and concepts requires the development of psychomotor skills and attitudes toward science.

PHILOSOPHY OF THE ELEMENTARY SCIENCE PROGRAM

Elementary science should provide children opportunities to extend their curiosity and to learn about the natural world through a series of planned learning experiences. By offering a diversity of interesting and challenging experiences, the science program will involve children directly in activity, observation and learning. It is through direct learning activities that children develop proficiency with the process skills of science and improve their abilities to think critically. By placing emphasis on these skills, the science program will help the child to evaluate and assimilate information rather than just accumulate it. Thus, the program should emphasize ways of gaining and processing information rather than learning information itself. Content serves as the subject matter for activities through which skills may be developed.

At the Division One level, the elementary science program recognizes that the child is in transition through the initial stages of intellectual development. The program provides opportunity for children to interact with their environment, to discover relationships and to make simple generalizations. The intent of the program at this level is to encourage and stimulate children's natural curiosity through exploration and discovery while emphasizing the communication skills to express their ideas and to learn from others.

At the Division Two level, the program prepares the child for more formal learning by introducing concepts at a more advanced level. The program maintains its emphasis on the development of the process skills with students actively participating in "hands-on" learning experiences. A variety of topics from the life, physical and earthspace sciences are built into the core program to provide a broad framework of experiences. The program at this level also places an emphasis on the environment and on energy resources with a view to using them responsibly.

GENERAL OBJECTIVES FOR SCIENCE EDUCATION

The elementary science program is designed to contribute to the achievement of the overall objectives for science in Alberta.

1. To develop the ability to inquire and investigate through the use of science process skills.

2. To promote assimilation of scientific knowledge.

3. To develop attitudes, interest, values, appreciations, and adjustments similar to those which are recognized as appropriate to the scientific endeavor.

4. To develop an awareness and understanding of the environment with positive attitudes and behaviours toward its use.

5. To develop an awareness of the role of science in the causes and resolution of some current social problems.

6. To promote awareness of the humanistic implications of science.

7. To promote an understanding of the role that science has in the development of societies and the impact of society on science.

8. To contribute to the development of vocational knowledge and skill.

DESIRABLE CHARACTERISTICS OF AN ELEMENTARY SCIENCE PROGRAM

The following statements identify desirable characteristics of an elementary science program. The program should:

- be activity-oriented. It should provide for individual student activities using a variety of objects through physical manipulation.
- be success-oriented. It should allow for the acceptance of student responses as an inquirer and help enhance the student's self-concept.
- be interesting. The learning experiences should not only be educational but also exciting in the eyes of the learner.
- be relevant. The experience should appeal to the natural curiosity of the child about things he learns, both in the classroom and beyond.
- be manageable for both teacher and student. The program should allow for easily implemented instructional techniques, readily grasped concepts, and meaningfully developed process skills.
- be diversified. Exploration and experience provided in the life sciences, the physical sciences, and space and earth sciences should be provided.
- be focused on the child's natural world. Learning through exploration and understanding of the natural environment and the man-influenced environment should be promoted.
- be integrated with other areas of study. Concepts and process skills should be cooperatively developed or expanded to other subject areas.
- develop the inquiry or process skills. The process skills provide for developing logical thinking patterns and systematic development of these skills through the grades.
- consider the psychomotor and intellectual levels of the child in the provision of learning experiences and expected learning outcomes.
- promote the development of attitudes of respect both for the scientific process and for the natural environments.

ELEMENTARY SCIENCE PROGRAM ELEMENTS

The elementary science program is comprised of four main elements: process skills, psychomotor skills, attitudes, and science concepts.

A. PROCESS SKILLS

The teaching of science as inquiry is the basic instructional strategy recommended in the Alberta elementary science curriculum. The strategy encourages the child to be actively involved in the learning process - not simply a passive listener or reader. Reading and listening are only two of the many ways of gaining information and, while they are skills worthy of being developed, the study of science involves development of other useful skills as well.

The principal goal of the elementary science program then, is the development of inquiry skills, also commonly referred to as the process skills. Through these skills, the child collects and processes information from the environment. The importance of these skills lies in their utility in obtaining and applying the most useful information toward answering questions and solving problems.

Process instruction is based on the premise that the behaviour of scientists can be analyzed into simple activities and that these can be arranged in a coherent, logical set. Processes, then, are the activities that scientists exhibit in their research or problem solving behaviour. As such, processes form the basis of problem solving, inquiry, investigating, experimenting, research projects or any similar activity. Although many sets of process skills exist, a system should be used that exhibits two main characteristics: 1) It should contain a valid list of activities representing scientific investigative behaviour; and 2) A structure or logical order is evident in the list.

An activity approach in science is not necessarily a process approach. In a process approach, activities must be continuously analyzed with the students as to which process skills are involved as well as understanding their functions. A variety of teaching techniques should be used to develop and implement the process skills. These techniques include discussions, films, investigations, demonstrations, and other effective strategies.

Strategies for teaching of the process skills should be incorporated into inquiry-oriented lesson and unit plans. In inquiry-oriented instruction, attention should be paid not only to teaching the process skills but also to giving the students opportunities to practise these skills.

After experiencing a process oriented program approach students should understand several basic concepts relative to the processes of science: 1) Process skills form a logical, coherent structure. They are not random! 2) Process skills form the basis for problem solving strategies that can be used in all aspects of life (i.e. they are integrative). 3) Process skills provide a mechanism for dealing with rapid change which is characteristic of our society. There are natural and logical relationships between and among the process skills.

Students must be given appropriate opportunities and activities to develop and operationalize problem solving skills. This implies that the teacher must step back from the role of presenter of information and instead, assume the role of director of activities. By so doing, the teacher places responsibility for thinking through and processing each experience on the student rather than on himself. The activities chosen will normally require the manipulation of materials rather than place heavy emphasis on reading or hearing about objects, situations or events.

The teaching for understanding of various skills should be timed in order to be appropriate for the level of intellectual growth of the child. This implies a sequence of skill development experiences starting with simple observation and classification in the primary grades, leading to complex skills such as defining operationally or formulating models in the upper elementary grades. As such, some of the skills should receive major emphasis in the beginning while others should be delayed and developed as the child matures to higher intellectual levels in later years.

Major Skills to be Emphasized in Division One

Observing - obtaining information about objects or events using the five senses. Observing is the most basic skill of science. Experiences or activities should involve objects or events in the child's immediate environment, including the world outside the classroom.

Classifying - organizing collections of objects or events according to common properties such as colour, shape, size, texture, etc. Classification systems are used to identify objects or events to show similarities, differences, and interrelationships.

Measuring - comparing objects according to size, mass, volume or temperature with accepted standards or conventional metric units. This process involves the use of numbers, measurement and of spatial relationships.

Communicating - describing objects, situations or events in a manner that can be interpreted by others. Communicating may involve the use of oral or written words, diagrams, maps, graphs, charts, mathematical expressions or visual treatment such as photographs.

Each of the four basic skills should be introduced in grade one and extended in each successive grade throughout the elementary school years by use of appropriate activities. This implies that the early experiences should be simple in nature and sequentially developed toward more demanding and complex experiences.

At the grade three level, conscious attention may be given to the skills of inferring and predicting providing the children show proficiency in the previous skills. Inferring should be introduced with simple activities to provide for a grasp of a topic which cannot come from observations alone. Similarly, predicting should be introduced with experiences designed to show the possible outcomes of systems they have been observing.

Major Skills to be Emphasized in Division Two

Inferring - a tentative explanation or conclusion based on direct or indirect observation. The skill involves conscious reasoning about observations. The skill may be best illustrated through the following example: given a closed box containing an unseen object, the child infers mass, or other properties. Direct observation is denied the investigator. Inferences based upon careful observation and founded on reliable information are apt to be of greatest value.

Predicting - involves the making of predictions based on a sequence or number of observations or measurements. Like all estrapolations on the known, predictions are recognized as probabilities rather than being assured. The quality of the prediction is measured by the probability that the outcome is as it was foretold.

Controlling Variables - the process of deciding which variables or factors will influence the outcome of an experiment, situation or event and deliberately controlling all recognized variables in a systematic manner.

Interpreting Data	- the method of getting the most out of data, in various forms such as graphs, histograms and tables, without loss of information inherent in the data. An inference may result from the interpretation of a particular set of data.
Defining Operationally	- objects and events are defined in a way which can be tested and observed. Operational definitions may at first be based on very simple tests and observations. Such definitions may later be modified and refined as the student learns to discriminate between closely related objects and events. For example, a simple operational definition of a pencil might be "a pencil makes marks (observation) when it is rubbed on a piece of paper (test). These marks can be erased by rubbing with a pink eraser (additional test)." A definition for the term "dissolve" is as follows: "a material is said to dissolve if it seems to disappear (observation) when it is added to a liquid (test)".
**Formulating Hypotheses*	- proposing a tentative explanation, based on previous observations, for the occurrence of a set of events. It can be a guess to guide an investigation (a working hypotheses) or accepted as highly probable in light of established facts.
Experimenting	- the ability to recognize and delimit a problem, plan and conduct a test of a hypotheses, and to use the collected results to pose possible answers to a problem. Experimenting is developed through a continuation of the sequence of controlling variables, interpreting data stating problems, constructing hypotheses, and carrying out investigative activities. Experimenting involves a combination of several process skills and formal reasoning or thinking skills. While experimenting can be introduced during the primary grades, it should be introduced only as students increase their experience with the more fundamental skills.

* The skill of hypothesizing should be introduced at the latter part of grade six, providing the student can demonstrate the proper intellectual maturity and has shown proficiency in the previous skills.

The Scientific Method

The process or inquiry skills of science are quite different from the popular notion of a "scientific method". The latter suggest that if a particular method is followed, scientific discoveries will follow. The behaviour of a scientist is less formal and is not always done in a clearly logical and systematic way. His thinking and method are both critical and creative. A scientist's approach includes any or all of the listed process skills, applied in any order.

Process Skill Inventories

The following is another inventory of process skills. A master list such as this should continuously be referred to so that an ordered perspective is developed relative to the process skills. It should be pointed out as implied previously, that although these processes are numbered from one to seventeen, no rigid order is implied. Scientific investigations do not proceed always in an orderly manner from one step to another. Furthermore in any given investigation it may not be necessary to include all the steps.

Summary of Processes in Scientific Inquiry

I. Initiation

1. Problem identification and definition
2. Seeking background information
3. Prediction
4. Hypothesizing
5. Designing collection of data through field work and/or experimentation

II. Collection of Data

6. Procedure
7. Observing and observations

III. Processing Data

8. Organizing the data
9. Representing the data graphically
10. Treating the data mathematically

IV. Conceptual of Data

11. Interpreting the data
12. Formulating operational definitions
13. Expressing data in the form of a mathematical relationship
14. Incorporating the new discovery into the existing theory (developing a "mental model")

V. Openendedness

15. Seeking further evidence
16. Identifying new problems for investigation
17. Applying the discovered knowledge

(Reference: "An Inventory of Processes in Scientific Inquiry" by Dr. M.A. Nay, et al.)

B. PSYCHOMOTOR SKILLS

Psychomotor skills include those skills which involve a coordination between the intellect and muscular movement. In the science program, psychomotor skills are involved in handling and manipulating a variety of materials such as water, sand, rocks, soil, magnets, magnifiers, electrical equipment and living things. In some cases, the skills involve very

specific movements requiring careful hand and eye coordination (e.g. measuring activities using balances, metre sticks, graduated cylinders and thermometers). In other cases, the movements are more large muscle based and simply learned (e.g. feeling objects for texture, pouring liquids and judging the mass of an object by its heft).

In general, the teacher should take advantage of whatever opportunities are available to involve students in psychomotor activities. By so doing, student skills can be practised and refined at a pace fitting to the student's own development.

Because of the complex nature of psychomotor skill development there has been no attempt in this guide to provide a prescribed program in detail. However, some basic guidelines for skills which should be developed have been included in the core program outlines.

C. ATTITUDES

Attitudes often determine what we do in given situations. Whether we try something or give up, whether we consider something worth caring about or unimportant; all of these are based on attitudes. The development of strong positive attitudes towards self and subject matter is one of the main goals of all school programs.

In the elementary science program particular attitudes to be developed include:

- an awareness, appreciation, and interest in the environment, and the need to display a responsible attitude toward its conservation;

- an appreciation of the beauty, uniqueness, and interdependence of all living things;

- an appreciation of science and the scientific enterprise in terms of the impact it has made on our lives;

- an interest in the value of science as a means of understanding the world; and

- an awareness and concern for the responsible use of energy resources.

In addition to these attitudes, the teacher should also encourage the development of:

- self-confidence on the part of students in their own developing abilities to explore and interpret objects and events in their own local environment; and

- a continuing interest in each area of science studied.

Development of attitudes in the classroom is usually based more on what we do than on what we say. Moral lectures on appropriate attitudes are not nearly as effective as the good example of a classroom teacher. Students use teachers as models; if they see teachers setting a good example, they will be influenced to do likewise. On the other hand, if students see a teacher who says one thing and does another, they may adopt this pattern of behaviour as well.

For example, for the classroom teacher to convey "an awareness and responsible use of energy resources" it would be appropriate for students to see the teacher taking deliberate steps to turn off lights when not needed, close windows and doors, and making wise use of paper and other school resources. Having set a good example, it is then appropriate for the teacher to require a similar standard for students, and to build good habits that will reinforce a conservation attitude.

To increase the depth of student attitudes, it may be helpful to discuss some of the implications of our actions. For example, if the class has been studying living things leading up to the development of "an appreciation of the beauty, uniqueness and interdependence of all living things" it may be appropriate to look at the students own impact on the school environment and the school yard. How aware are students of living things that are found in their own school yard? What effect do students have on flowers, trees, grass, earthworms and insects that may live in the yard? Are these living things to be valued or should they just be taken for granted?

The care given to living things kept in the classroom is particularly important to attitude development. In the eyes of the student, what appears to be more important, the welfare of the plant or animal kept in the classroom or the expediency of using the animal to teach a concept? Students will be sensitive to and aware of the approaches used by the teacher. If the teacher is concerned and sensitive, in time the students will be also.

D. SCIENCE CONCEPTS

The elementary science program of studies focuses upon three major concept areas:

i) Matter and Energy
ii) Living Things and Environments
iii) Earth, Space and Time.

For each Division, topics of study (subject matter) have been identified for each of the concept areas. The student will have an opportunity to develop an understanding of the nature of the world through the study of concepts in life science, physical science and earth-space sciences.

The topics of study are intended to serve as a general survey of the concept areas identified. The intent is to provide students with an introductory understanding of certain aspects of the concept area without delving into great detail or emphasis on abstract ideas. The developmental level of the student must be a prime consideration when presenting concepts that are of an abstract nature. Wherever appropriate the subject matter should be introduced through an activity based experience.

Many of the concepts introduced in the elementary science program are further developed, extended, or maintained in the Junior High science program. It is at the Junior High grades or higher, in particular, where concepts can be dealt with at a more abstract or complex manner.

A. CORE-ELECTIVE FORMAT

The program of studies consists of core and elective components. The core program consists of skills, concepts and attitudes that are to be learned and developed by all elementary school students in Alberta. The suggested allocated time for teaching the core program should range between 60-70% of the total time allotted for science instruction.

The elective component provides an apportunity for teachers to choose from a variety of topics in order to complete the program in the time given to elementary science. Teachers may select from chapters designated as elective in text programs, appropriate commercially available units of study, and locally developed units. The intent of the elective component is to provide teachers with greater flexibility in planning their programs to meet student needs and to utilize local resources.

B. SUGGESTED MINIMAL TIME ALLOTMENT

The chart below describes the suggested time allotment for elementary science by Division:

Division	Time (min.wk.)	Time (hrs./yr.)	Core	Elective
I	90	60	36 hrs./yr. (60%)	24 hrs./yr. (40%)
II	120	80	48 hrs./yr. (60%)	32 hrs./yr. (40%)

C. USING THE PROGRAM ALTERNATIVES

Four learning resource alternatives have been prescribed for use with the program. Each alternative meets the requirements of the core component but varies in terms of teaching method and the balance between reading for concept formation and the emphasis on student inquiry. Teachers and school systems should examine each program alternative carefully and choose the one that best suits their instructional preferences and available equipment and facilities.

Alternative four allows the teacher or school system greater flexibility in the choice of materials and instructional approach. However, the use of this alternative requires organization and planning and should be attempted by teachers who have a strong science background (methods and programs) or by systems where consultative help and other support is available.

D. DESIGNATION OF CORE AND ELECTIVE COMPONENTS

Chapters, units or lesson clusters in each of the text series (Alternatives 1, 2, 3) have been designated as core or as elective. The designated core units should be covered to meet the program of studies requirements. The teacher may wish to use the remaining chapters or units as elective, or fulfill the remaining elective component with locally or commercially developed material. Refer to the correlation charts on pages 62-91.

Alternative #4 is designed to provide greater flexibility in the choice and use of a variety of available learning resources. Teachers or systems using this alternative will need to organize and plan the sequence of the selected resources (or portions thereof) to meet the core and elective requirements prescribed for each Division.

E. DIVISION SPECIFIC OBJECTIVES

The program of studies defines the skills, content and attitudes to be developed and acquired at the end of each Division. Hence, the curriculum is Division specific and not grade specific. This has been done to allow for selection from the prescribed resource alternatives.

To assist teachers in identifying the expected student learning outcomes for each grade level, this curriculum guide identifies chapters in each text alternative which will meet core program requirements.

F. PRESCRIBED RESOURCES FOR CORE PROGRAM COMPONENT

Four resource alternatives are provided:

Resource Alternative One: *Science*, Berger, et al., Houghton Mifflin Canada, Ltd., 1979.

Resource Alternative Two: *Addison-Wesley Science*, Rockcastle, et al., Addison-Wesley Canada, Ltd., 1980.

Les Chemins de la Science, Rockcastle, et al., French edition, Addison-Wesley Canada, Ltd., 1978.

Resource Alternative Three: *Exploring Science*, Blecha, et al., Doubleday Canada Ltd., 1977.

Resource Alternative Four: Multiple Reference

(a) *Examining Your Environment*, Wentworth et al., Holt, Rinehart and Winston, 1976-1977.

i) *Ecology of Your Community*
ii) *Mini Climates*
iii) *Pollution*
iv) *The Dandelion*
v) *Birds*
vi) *Your Senses*
vii) *Small Creatures*
viii) *Mapping Small Places*

(b) *Elementary Science Study (ESS)*, Education Development Center, McGraw-Hill Ryerson, 1967-1975.

i) *Growing Seeds*
ii) *Light and Shadows*
iii) *Life of Beans and Peas*
iv) *Clay Boats*
v) *Sink or Float*
vi) *Starting From Seeds*
vii) *Brine Shrimp*
viii) *Gasses and Airs*
ix) *Balloons and Gases*
x) *Changes*
xi) *Attribute Games*
xii) *Pond Water*
xiii) *Small Things*
xiv) *Ice Cubes*
xv) *Behaviour of Mealworms*
xvi) *Coloured Solutions*
xvii) *Optics*
xviii) *Mystery Powders*
xix) *Whistles and Strings*
xx) *Musical Instrument Recipe Book*
xxi) *Batteries and Bulbs*
xxii) *Heating and Cooling*
xxiii) *Kitchen Physics*

(c) *Science in Action Series*, MacKillian, et al., McGraw-Hill Ryerson, 1973-1976.

i) *The Outdoors: Studies for Open Places*
ii) *The Outdoors: Studies for Woodlands*
iii) *Studying Birds*
iv) *Studying Soil*
v) *Studying Insects*

vi) *Studying Streams*
vii) *Studying Plants*
viii) *Studying Mammals*

(d) *Rand McNally SCIIS*, Thier, et al., Gage Publishing Co., 1978.

i) Physical/Earth Science Sequence
Level 1 - *Material Objects*
Level 2 - *Interaction and Systems*
Level 3 - *Subsystems and Variables*
Level 4 - *Relative Position and Motion*
Level 5 - *Energy Sources*
Level 6 - *Scientific Theories*

(e) *Science: A Process Approach II*, American Association for the Advancement of Science, Ginn and Company, 1974.

i) Grade 1 - Modules 1 to 15
ii) Grade 2 - Modules 16 to 30
iii) Grade 3 - Modules 31 to 45

(f) *MacDonald 5/13 Science*, Richards, et al., GLC Publishers Ltd., 1973-76.

i) *Early Experiences, Stage I*
ii) *Change 1 and 2 and Background*
iii) *Early Explorations - Using the Environment*
iv) *Investigations, Part 1 and 2*
v) *Tackling Problems, Part 1 and 2*

G. RECOMMENDED RESOURCES FOR ELECTIVE PROGRAM COMPONENT

1. *Examining Your Environment*, Wentworth, et al., Holt, Rinehart and Winston, 1976-77.

i) *Running Water*
ii) *Trees*
iii) *Snow and Ice*
iv) *Astronomy*

2. *Elementary Science Study (ESS)*, Education Development Center, 1967-1975.

i) *Structures*
ii) *Batteries and Bulbs II*
iii) *Stream Tables*
iv) *Rocks and Charts*

v) *Drops, Streams and Containers*
vi) *Pendulums*
vii) *Mapping*
viii) *Microgardening*
ix) *Eggs and Tadpoles*
x) *Tracks*
xi) *Daytime Astronomy*
xii) *Budding Twigs*

3. *MacDonald 5/13 Science*, Richards, et al., GLC Publishers Ltd., 1973-76.

i) *Time - Stages 1 and 2 (Background)*
ii) *Trees - Stages 1 and 2*
iii) *Ourselves - Stages 1 and 2*
iv) *Minibeasts - Stages 1 and 2*

4. *WEDGE Resources*, Western Education Development Group, University of British Columbia, 1973-79.

i) *There's Dirt in the Forest*
ii) *The Snow Book*
iii) *Seeing Through Trees*
iv) *The Pond Book*
v) *The Creek Book*
vi) *Science on a Kite String*
vii) *The Jolly Green Classroom*
viii) *Grounds For Erosion*
ix) *Classroom Cameras*
x) *Cast Your Class to the Wind*
xi) *Kids and Kites*

PROGRAM OF STUDIES

A. OVERVIEWS

I. DIVISION ONE CORE OVERVIEW

Process Skills:

Observing, Measuring, Classifying, Communicating, *Inferring, *Predicting.

The major emphasis of the Elementary Science program is on the development of the process skills.

*To be introduced toward the latter part of Division One.

Psychomotor Skills:

- Development of the motor-perceptual skills (e.g. eye-hand coordination, small muscle control) through direct manipulation and effective use of apparatus.

  e.g. metre sticks
  tape measures
  magnets
  simple balances
  hand lens
  thermometers
  microscopes
  simple hand tools

Attitudes:

- An awareness, appreciation and interest in the environment, and the need to display a responsible attitude toward its conservation.
- An appreciation of the beauty, uniqueness and interdependence of all living things.
- An appreciation of science and the scientific enterprise in terms of the impact it has made on our lives.
- An interest in the value of science as a means of understanding the world.
- An awareness of, and concern for, the responsible use of energy resources.

Concept Areas:

I. Matter and Energy

Topics: A. Properties of Objects
B. Properties of Matter
C. Energy

II. Living Things and Environment

Topics: A. Living Things
B. Plants and Animals
C. Populations
D. Environment

III. Earth/Space/Time

Topics: A. Position and Direction
B. Order and Time

II. DIVISION TWO CORE OVERVIEW

Process Skills:

Observing, Measuring, Classifying, Communicating, Inferring, Predicting, Controlling Variables, Interpreting Data, Experimenting, *Defining Operationally, *Formulating Models, *Formulating Hypotheses.

The major emphasis of the Elementary Science program is on the development of the process skills.

*To be introduced with lighter emphasis.

Psychomotor Skills:

- Development of the motor-perceptual skills (e.g. eye-hand coordination, small muscle control) through direct manipulation and effective use of apparatus.

  e.g. metre sticks
  tape measures
  magnets
  simple balances
  hand lens
  thermometers
  microscopes
  simple hand tools

- Ability to construct and use simple apparatus and instruments.

  e.g. anemometers
  wind direction indicators
  clinometers
  measuring instruments

- Ability to construct or assemble equipment to pursue projects of special interest.

  e.g. electric quiz boards
  simple electric motors
  aquariums
  terrariums
  stream tables
  pin hole cameras

Attitudes:

- An awareness, appreciation and interest in the environment, and the need to display a responsible attitude toward its conservation.
- An appreciation of the beauty, uniqueness and interdependence of all living things.
- An appreciation of science and the scientific enterprise in terms of the impact it has made on our lives.
- An interest in the value of science as a means of understanding the world.
- An awareness of, and concern for, the responsible use of energy resources.

Concept Areas:

I. Matter and Energy

Topics: A. Changes in Matter
B. Sound
C. Light
D. Electricity
E. Magnetism
F. Heat
G. Energy Resources and Conservation

II. Living Things and Environment

Topics: A. Environmental Factors
B. Adaptations
C. Ecosystems
D. Environment

III. Earth/Space/Time

Topics: A. Weather
B. Water and Land

Process Skills:

Observing, Measuring, Classifying, Communicating, Inferring, Predicting.

The major emphasis of the Elementary Science program is on the development of the process skills.

Psychomotor Skills:

- Development of the motor-perceptual skills (e.g. eye-hand coordination, small muscle control) through direct manipulation and effective use of apparatus.

  e.g. metre sticks
  tape measures
  magnets
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Attitudes:

- An awareness, appreciation and interest in the environment, and the need to display a responsible attitude toward its conservation.
- An appreciation of the beauty, uniqueness and interdependence of all living things.
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- An interest in the value of science as a means of understanding the world.
- An awareness of, and concern for, the responsible use of energy resources.

Concept Area:

I. Matter and Energy

A. Properties of Objects

Descriptive Statement

Objects can be identified, grouped and ordered on the basis of physical properties such as colour, size, shape, texture, taste,

mass, volume, smell, sound. Students use their senses to compare and group objects.

Subject Matter

1. Objects exhibit a number of properties.
2. Properties of objects can be determined through the use of the senses (touch, hearing, taste, smell, sight).
3. Colour, shape, size, texture, hardness and mass are properties of samples of matter.
4. Objects can be compared, ordered and classified according to one or more properties.

B. Properties of Matter

Descriptive Statement

Matter occupies space, has mass and can be classified into three distinct forms (solids, liquids, gases). When matter changes form its properties are altered. Students observe and describe matter and its changes.

Subject Matter

1. Samples of solids have distinct properties: (a) they tend to retain their shape; (b) they can be poured only if in small pieces; (c) they have measurable mass.
2. Some solids can be classified as metals.
3. Some solid materials float in water or sink in water.
4. Some solids dissolve readily in water; others do not.
5. Some solids are attracted by magnets, others are not attracted by magnets.
6. Magnets either attract or repel other magnets.
7. Liquids have distinct properties: (a) they take the shape of the container; (b) they can be poured; (c) they can form drops.
8. Liquids vary in the degree of specific properties such as: (a) colour; (b) transparency to light; (c) viscosity; (d) density.
9. Gases have distinctive properties: (a) occupies space; (b) exerts pressure; (c) have mass; (d) are not necessarily odorless and colourless.
10. Matter can undergo changes (e.g. heating, cooling, freezing, melting.

C. Energy

Descriptive Statement

Heat, light, sound, electricity are common forms of energy. Students infer the presence and transfer of energy by observing interactions. The sun is identified as the primary source of the earth's energy.

Subject Matter

1. There are different forms of energy (e.g. heat, light, sound, electricity).
2. Temperature is a measure of heat energy and can be measured with a thermometer.
3. Change of heat energy generally causes matter to expand or contract.
4. The sun is a source of light and heat.
5. Plants and animals use energy from the sun.
6. Humans can exhibit behaviours that conserve energy in their environment (home, school).

Concept Area:

II. Living Things and Environments

A. Living Things

Descriptive Statement

Objects can be classified as living or non-living according to certain characteristics. Students observe, describe and compare living and non-living things.

Subject Matter

1. Things can be classified as living or non-living on the basis of the following characteristics:
   (a) living - need food and water, grow, die, reproduce.
   (b) non-living - do not need food, do not grow, do not die, do not reproduce.
2. Living things can be classified according to properties: e.g. method of locomotion, habitat, food gathering, structure, life cycle.

B. Plants and Animals

Descriptive Statement

Plants and animals grow, require food, water and air, and respond to their environment. Students observe, measure and describe changes in growth, and identify factors necessary for life.

Subject Matter

1. Plants are living things: (a) which require water and sunlight (for most plants); (b) which grow; (c) need soil or other sources of nutrients.
2. Seeds have certain requirements for growth and are dispersed in many ways.
3. Plants differ from animals in specific ways relative to how they obtain food, react to stimuli and move.
4. Animals are living things which: (a) grow; (b) feed on other animals and plants; (c) move; (d) reproduce.
5. Animals (e.g. families, species) have similar and different characteristics.

6. Domestic animals require care to meet their needs.
7. Plants and animals respond to stimuli in their environment (light, moisture, temperature, food).
8. Plants and animals live in many different habitats within an environment.
9. Young plants resemble their parents. Some animals reproduce young which resemble their parents. Others animals do not resemble their parents until mature.

C. Populations

Descriptive Statement

Populations are groups of organisms that grow and develop in a certain environment and are in a constant state of change. Students construct habitats (terrariums or aquariums) to observe and describe interacting populations and change.

Subject Matter

1. The term "population" describes a group of organisms of the same kind in a particular environment.
2. The place of a population is its habitat.
3. Populations in a particular habitat form a community.
4. Populations are in a state of change. They are affected by:
   (a) environmental factors (moisture, temperature, light;
   (b) other populations, e.g. predators, man.

D. Environment

Descriptive Statement

Through outdoor studies and interaction with their environment, students should develop an awareness and sensitivity toward the environment and motivation for actively participating in its protection and improvement.

Subject Matter

1. The environment can be classified as man-made and natural.
2. Humans can change the environment in many ways.
3. It is important to protect and maintain the environment.
4. The environment plays an important role in our lives.

Concept Area:

III. Earth/Space/Time

A. Position and Direction

Descriptive Statement

Position of an object is located in terms of distance and direction from a reference object. Students describe and measure the position (distance, direction) of an object.

Subject Matter

1. An object's position, size and direction can be described by the terms: up/down, forward/back, right/left, short/tall, in/out, near/far and above/below.
2. The position of an object is determined relative to arbitrarily chosen reference points.
3. An object's position can be determined by using a simple grid.
4. Distance can be measured using standard and non-standard units.

B. Order and Time

Descriptive Statement

Events occur and change in a particular order of sequence having varying durations of time. Students describe and measure changes that take place over time in objects and in the environment.

Subject Matter

1. Some changes occur in a regular pattern and can be ordered, e.g. seasons, plant and animal growth.
2. Some changes are reversible (e.g. freezing, melting) and others are not (e.g. rusting, rotting).
3. Some changes occur slowly and others rapidly.
4. Weather can exhibit different kinds of change.
5. Various changes occur in the environment over time (e.g. effects of erosion, decomposition, weathering).

C. DIVISION TWO CORE

Process Skills:

Observing, Measuring, Classifying, Communicating, Inferring, Predicting, Controlling Variables, Interpreting Data, Experimenting, *Defining Operationally, *Formulating Models, *Formulating Hypotheses.

The major emphasis of the Division Two core program is on the development of the process skills.

* To be introduced with lighter emphasis.

Psychomotor Skills:

- development of the motor-perceptual skills (e.g. eye-hand co-ordination, small muscle control) through direct manipulation and effective use of apparatus.

  e.g. metre sticks
  tape measures
  magnets
  simple balances
  hand lens
  thermometers
  microscopes
  simple hand tools

- ability to construct and use simple apparatus and instruments.

  e.g. anemometers
  wind direction indicators
  clinometers
  measuring instruments

- ability to construct or assemble equipment to pursue projects of special interest.

  e.g. electric quiz boards
  simple electric motors
  aquariums
  terrariums
  stream tables
  pin hole cameras

Attitudes:

- An awareness, appreciation and interest in the environment, and the need to display a responsible attitude toward its conservation.

- An appreciation of the beauty, uniqueness and interdependence of all living things.

- An appreciation of science and the scientific enterprise in terms of the impact it has made on our lives.

- An interest in the value of science as a means of understanding the world.

- An awareness of, and concern for, the responsible use of energy resources.

Concept Area

I. Matter and Energy

A. Changes in Matter

Descriptive Statement

Changes in matter can be classified as physical changes or chemical changes. Students observe, infer and describe these changes. Students observe and perform tests to identify the distinguishing properties of solids, liquids and gases and classify matter on the basis of these properties.

Subject Matter

1. Physical changes alter such properties as size, shape, form, colour. These changes are usually reversed.
2. Chemical changes produce new materials with different properties. Some chemical changes can be reversed but most are more difficult (e.g. burning).
3. Materials can be classified as acids, bases or neutral by their effect upon indicators such as litmus or bromothymol blue (BTB) solution.
4. Liquids differ in properties such as density, cohesiveness, surface tension.

B. Sound

Descriptive Statement

Vibrating matter causes sound. Students observe and describe conditions necessary to produce sound and manipulate variables that cause changes in sound.

Subject Matter

1. Sound is caused by vibrations.
2. The pitch of a sound is determined by the number of times an object vibrates in a given time (frequency).
3. Sound becomes less audible as the distance between the observation and the source increases.
4. Solids generally conduct sound better than liquids or gases such as air.
5. Some materials vary in their ability to conduct or absorb sound.
6. Noise pollution is a serious problem and can be controlled.

C. Light

Descriptive Statement

Light is a form of energy that tends to travel in straight lines and can be reflected, refracted and absorbed. Through the uses of lenses, mirrors and prisms students observe and describe the behaviour of light (optics).

Subject Matter

1. An object may be seen when it reflects light.
2. Light tends to travel in straight lines.
3. Some objects produce their own light.
4. Light becomes less intense as the distance between the observation and the source increases.
5. The colour, lustre and composition of material affects the degree to which it reflects or absorbs light.
6. Lenses and prisms can be used to concentrate or disperse light.
7. White light is a combination of light of all the colours of the spectrum.
8. A beam of light can be reflected or refracted.
9. Objects can be classified as transparent, opaque or translucent.

D. Electricity

Descriptive Statement

Electrical energy can be transformed into other energy forms. Students construct simple circuits and manipulate variables to infer the path that electricity travels.

Subject Matter

1. When some materials are rubbed together, the materials receive an electrical charge.
2. An object that has an electrical charge can attract or repel another charged object.
3. There are two different kinds of electrical charges (a positive charge and a negative charge).
4. Electrical charges moving through a conductor form an electrical current.
5. An electrical current can be produced by chemical means.
6. Simple electrical circuits can be constructed using a bulb, wire and a cell.
7. In a simple circuit certain variables can be manipulated (number of bulbs, cells, thickness and length of wire).
8. Circuits can be open (incomplete) or closed (complete).
9. Certain materials are better conductors of electrical energy than others (conductors, non-conductors).

E. Magnetism

Descriptive Statement

Magnetism is a property of some materials. Students will observe and describe properties of magnets and distinguish between materials that are attracted by magnets and those that are not.

Subject Matter

1. Some materials are attracted by a magnet and others are not.
2. Magnets have two poles.
3. Unlike poles of any two magnets attract, while like poles repel.
4. The strength of magnets (magnetism) can be increased.
5. Some materials (common iron and steel) can be magnetized.
6. When an electrical current passes through a coiled wire it produces an electro-magnet.
7. The magnetic field extends beyond the magnet itself.

F. Heat

Descriptive Statement

Heat is a form of energy that can produce changes in the properties of matter. Students manipulate heat variables that affect matter and use thermometers to measure heat change.

Subject Matter

1. Heat energy passes through some materials easily (conductors) and not so easily in others (insulators).
2. Heat gain or loss can be indicated using a thermometer.
3. Heat energy transfers from warmer objects to cooler objects.
4. The kind of matter and its colour are variables that affect the rate of heat energy transfer.
5. Conduction and convection are two ways heat energy can be transferred.
6. Contraction or expansion of matter and other physical changes are caused by gain or loss of heat energy.

G. Energy Resources and Conservation

Descriptive Statement

The world's energy resources are in limited supply and should be conserved. Students examine renewable and non-renewable energy resources and man's consumption of energy.

Subject Matter

1. Energy resources can be classified as renewable and non-renewable.
2. Energy exists in many forms (e.g. light, heat, chemical, nuclear).
3. Alberta has a number of major energy resources (coal, sunshine, oil, natural gas).
4. Our lifestyle and consumer behaviour determine our use and misuse of energy sources.
5. Alternative energy resources (e.g. solar, wind, biomass, thermal, nuclear) exist in addition to the fossil fuels.
6. There are advantages, disadvantages, problems, costs and risks associated with all energy resources.
7. Energy can be conserved in many ways (e.g. recycling and reuse of waste products, change in consumer demands, change in life-style, change in technology).
8. New sources of energy will be required in the future (e.g. fusion, gasohol).
9. Society must examine the "trade-offs" that are part of our energy consuming lifestyle.
10. Our use of energy can have adverse effects on the environment (extraction, production, consumption, waste energy).

Concept Area

II. Living Things and Environment*

A. Environmental Factors

Descriptive Statement

Organisms live where environmental factors are suited to their needs. Students manipulate such variables as moisture, temperature and light and describe and infer their effect on a population.

Subject Matter

1. Organisms respond to environmental factors of light, temperature and moisture.
2. Organisms live in habitats that have factors favourable to their survival.

B. Adaptations

Descriptive Statement

Adaptations allow plants and animals to survive in their environment. Students examine structural and behavioural adaptations.

Subject Matter

1. Camouflage is one kind of adaptation.
2. Structural and behavioural adaptations enable organisms to survive in their environment.
3. Some organisms develop through stages of a life cycle with each stage exhibiting special adaptations.
4. Organisms show behavioural adaptations to environmental changes (e.g. migration, hibernation).

C. Ecosystems

Descriptive Statement

Living and non-living things interact in an ecosystem. Interacting populations (communities) require matter and energy from the environment for survival. Students examine food chains, food webs and various cycles (life, energy) that are part of the ecosystem.

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* Supplement with Flora and Fauna of Alberta Heritage Learning Resources Kit.

Subject Matter

1. Organisms interact within a community.
2. Populations of animals depend on other populations for food: (a) the plant eaters (herbivores; (b) the animal eaters (carnivores).
3. Some animals interact in a predator-prey relationship.
4. Food is cycled within an environment (producer - consumer - decomposer).
5. Populations interact with each other in food chains and more complex food webs.
6. Green plant populations are classified as producers.
7. Human populations are consumers.
8. Populations compete for the things they require to sustain life.
9. The living and non-living parts of an environment make up an ecosystem.
10. Populations change in response to changes in the ecosystem.

D. Environment

Descriptive Statement

Man's use of land, air and water can create complex problems. The student infers and describes man's influence (positive and negative) on the environment.

Subject Matter

1. Living things survive when they adapt to changes in their environment.
2. Some living things have adapted to man and some have been endangered by his actions.
3. The earth is a closed system with the exception of exchange of energy with space.
4. Man's influence on the environment has been positive and negative (e.g. chemicals capable of pest control and improved soil fertility are also capable of being harmful to the environment).
5. People need to examine solutions for environmental problems and consider steps to improve the quality of the environment.
6. Man's future will be influenced by his present consumer behaviour and interaction with the environment.

Concept Area

III. Earth/Space/Time

A. Weather

Descriptive Statement

Weather consists of interacting factors such as temperature, pressure, precipitation and humidity. Students observe, measure, record and predict weather conditions and changes.

Subject Matter

1. Weather consists of interacting factors such as temperature, pressure, precipitation and humidity.
2. Weather factors can be measured in many ways (e.g. thermometers, anemometers, barometers, rain gauges).
3. Clouds require certain conditions for their formation.
4. Wind is caused by the movement of air masses.
5. Rain is formed when many small cloud droplets condense.
6. Warm air rises when it is pushed up by cooler, heavier air.

B. Water and Land

Descriptive Statement

Moving water erodes and changes the land over time and water is recycled within the earth-atmosphere system. Students describe the water cycle in terms of evaporation, condensation, precipitation and run-off.

Subject Matter

1. Moving water erodes and changes the land over a time.
2. Many geological formations (e.g. oxbows, deltas) are as a result of the force of moving water.
3. Soils differ in their capacity to retain or hold water.
4. The water cycle plays an important role in maintaining the earth's surface water.
5. The water cycle is affected by weather conditions.
6. Water is a precious natural resource that should be conserved and kept unpolluted.
7. Reduced water quality in oceans, seas, rivers, lakes can be a serious problem to the environment and mankind.

D. ELECTIVES

I. NATURE OF THE ELECTIVE

1. The elective portion of the program should comprise approximately 40% of the instructional time allotted for elementary science. The table below suggests an allocation of time for Division One and Two core and elective components. The number of hours indicated have been determined on the basis of time suggested by the authors of the learning resources and the field pilots.

	Core	Elective	Total
Division One	36 hours	24 hours	60 hours (90 minutes per week)
Division Two	48 hours	32 hours	80 hours (120 minutes per week)

2. The elective portion of the program can be covered on a regular basis throughout the school term (e.g. once a week, twice a month) or be consolidated into larger blocks of time (e.g. 2 week units).

3. The context of the elective may be:

   a) an extension of the subject matter in any of the core topic areas.
   b) a content area not prescribed as a core topic area but covered by the text series being used.
   *c) locally developed units as determined by the teacher or school system.
   *d) determined by student and/or teacher interests.

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* The Flora and Fauna of Alberta Kit can be resequenced for use as elective topics.

II. SUGGESTED ELECTIVE TOPICS

Topic	Suggested Division	Suggested Resources
1. Trees	Division 1	Budding Twigs - ESS Trees - 5/13 Forest Appreciation - WEDGE
	Division 2	Trees - EYE Budding Twigs - ESS Studies for Woodlands - Ryerson Flora & Fauna Kit Seeing Through Trees - WEDGE
2. Mapping	Division 1	Mapping - ESS
	Division 2	Mapping Small Places - EYE
3. Winter Studies	Division 1	Snow and Ice - EYE Miniclimates - EYE
	Division 2	Snow and Ice - EYE Miniclimates - EYE The Snow Book - WEDGE
4. Crystals	Division 1	Texts and library references
	Division 2	Texts and library references
5. Rocks and Minerals	Division 1	Rocks and Charts - ESS
	Division 2	Rocks and Charts - ESS
6. Soil Studies	Division 1	There's Dirt in the Forest - WEDGE
	Division 2	Studying Soil - Ryerson Running Water - EYE Grounds for Erosion - WEDGE
7. Indepth Life Studies, e.g. fish reptiles, insects birds, mammals, dinosaurs, plants	Division 1 & Division 2	Flora & Fauna Ket Question Mark Trail Trees - 5/13 Eggs and Tadpoles - ESS Small Creatures Dandelion - EYE

Cont'd

Topic	Suggested Division	Suggested Resources
		Studying Mammals - Ryerson Studying Insects - Ryerson Studying Birds - Ryerson Studying Plants - Ryerson Mealworms - EYE Brine Shrimp - ESS Birds - EYE Life of Beans and Peas - ESS Microgardening - ESS Minibeasts - 5/13 Series The Jolly Green Classroom - WEDGE
8. Dinosaurs	Division 1	Texts and library references
9. Fossils	Division 2	Texts and library references
10. Environmental Studies	Division 1 & Division 2	Tracks - ESS Pond Water - ESS Studies for Open Places - Ryerson Studies for Woodlands - Ryerson Studying Streams - Ryerson Flora & Fauna Kit Miniclimates - EYE Ecology of Your Community - EYE Pollution - EYE Minibeasts - 5/13 Stream Tables - ESS Running Water - EYE The Pond Book - WEDGE The Creek Book - WEDGE Science on a Kite String - WEDGE There's Dirt in the Forest - WEDGE Cast Your Class to the Wind - WEDGE
11. Space Travel Flight	Division 1 Division 2	Texts and library references Texts and library references

Cont'd

Topic	Suggested Division	Suggested Resources
12. Microscope Studies	Division 2	Small Things - ESS Microgardening - ESS Cells - text resources
13. Light and Shadows	Division 1	Light and Shadows - ESS
	Division 2	Optics - ESS
14. Astronomy	Division 2	Daytime Astronomy - ESS Astronomy - EYE Text resources
15. Simple Machines	Division 1	Text resources
	Division 2	Text resources
16. Projects - collections - Science Fair - constructing models - care of living things - consumer product testing - student interest	Division 1	Drops, Streams and Containers - ESS Pendulums - ESS Time - 5/13
	Division 2	Batteries and Bulbs II - ESS Science on a Kite String - WEDGE Classroom Cameras - WEDGE Kids and Kites - WEDGE

ORGANIZATION FOR INSTRUCTION

A. INSTRUCTIONAL STRATEGIES

Each learning experience is based, at least in part, on a direct learning situation. In each experience the child is confronted with a new situation or new materials which he explores, sometimes freely and at other times within a structured learning activity. Through this manipulation of materials the child is given opportunities to apply the process skills: observing, classifying, measuring and so on. Development of these skills is in part spontaneous and in part guided by the teacher through the use of focussing questions and directed activity tasks.

Following from the experience, one or more main ideas or concepts emerges. These concepts can be developed verbally, first by giving students opportunities to discuss the specifics of their experiences then by class discussion of the larger ideas or concepts that are involved. Once established, the range and limits of the new concept should be explored. The extension of the concept or idea may involve further activities and application of process skills, or it may involve extending the experience through reading, discussion or use of audio-visual materials.

The emphasis on process skill development through a student activity approach may require changes in instructional strategies. There will be an increased emphasis on:

i) individual group activities.
ii) handling of equipment and materials which will necessitate greater demands on ability to organize and distribute equipment and materials.
iii) outdoor studies.
iv) student participation and less emphasis on teacher demonstrations.
v) integration with other subject areas.

Teachers doing activity-based science for the first time should proceed slowly in terms of initially setting simple tasks that can be done in a short period of time before pursuing a strong activity program. This allows opportunity for developing discipline and control, organizing materials and training students in activity science in terms of expectations regarding performance, conduct, and safety.

Being organized in terms of equipment is a key factor in the success of an activity program. This includes storage of equipment, access to materials by students, methods of distributing resources, clean-up and returning equipment to the appropriate place.

The skills and subject matter of the new program provide ample opportunity for integration with other subject areas. The teacher should plan to develop certain concepts in mathematics (e.g. graphing, measuring) through appropriate science activities. In the same way science can be integrated with social stucies, e.g. study of resources in grade 4 using a decision-making social action model.

Integration and interdisciplinary approaches provide more instructional time for science since the process skills in science are basically similar to those being developed in the other subject areas (e.g. communication skills in language arts, measuring skills in mathematics, etc.).

The teacher's edition of each of the resource alternatives provides fairly detailed information regarding:

i) advance preparations
ii) grouping of students for particular activities
iii) equipment/facility needs
iv) instructional strategies to be used
v) background information
vi) evaluation
vii) integration
viii) extension and enrichment.

B. ALLOCATION OF TIME

The activity-oriented program requires ample time within the science period for activities to be carried out to completion. It is strongly advised that school systems follow the recommended minimum time allotments suggested earlier in the curriculum guide for Divisions 1 and 2.

Specific time allotments for each lesson are suggested by the authors in the teachers' edition of the textbook. The time allotted for a science period should be ample to conduct the


OBSERVING
PREDICTING
CLASSIFYING
USING TIME
& SPACE
RELATIONSHIPS

activities. This may require that occasionally the science period may have to be extended.

C. CLASSROOM ORGANIZATION

Class size is a major factor in any activity-oriented program. While smaller class sizes provide certain advantages in organizing for instruction, careful planning and preparation on the part of the teacher can ensure success with large classes. Several guidelines are suggested in terms of "doing activity science" with large classes. These are:

i) use of small groups with the task or activity clearly outlined and the expected outcome understood
ii) proceeding slowly through activities, one task at a time
iii) splitting the class so that one group does activities while another group is involved in seat work (reading, research, discussion, etc.)

iv) use of teacher aides or paraprofessionals
v) setting a specific time period in which a task must be completed
vi) giving members in groups specific tasks to perform (e.g. occupy their time with things to do or be responsible for.

For split grades it is recommended that cycling of text resources not be used (e.g. use of grade 5 resources in grade 4 and grade 4 resources in grade 5). It is recommended that alternatives be considered for

for split grades. These include:

i) covering half of the concept strands or themes of a particular resource but over two grades, e.g. for a grade 4-5 split using Houghton Mifflin cover the Living Objects and Order in Space/Time themes for grade 4 and 5 in the first year and the following year cover Change and Interaction and Structural Patterns themes for grades 4 and 5.

ii) having the system determine one set of core topics to be covered during the first year of the split class and another set of topics the second year. This requires system planning and organization.

D. CLASSROOM MANAGEMENT

In the science programs outlined in this guide, students learn by becoming active participants in the learning process. This learning process takes a variety of forms including viewing, listening, reading, writing and discussing as well as direct hands-on learning experiences.

The teacher's role is mainly to guide and manage the total learning process rather than to be primarily a source of information. Effective management of the science classroom is thus critically important to the program's success. Following are some suggestions for effective management that have been found to be helpful.

1. Be Well Prepared

- Check that all needed materials are available for each activity.
- Become familiar with each activity by trying it out in advance.
- Prepare and assemble materials in advance.

2. Use a Variety of Materials and Approaches

- Combine investigative problem solving activities with the related language skills of listening, reading, writing and speaking.
- Use a variety of manipulative materials and equipment.
- Use reading materials for supporting and reinforcing learning.
- Use audio-visual materials for introduction, reinforcement and extension of learning activities.

3. Establish Routines

- Establish routines to handle events that come up regularly rather than deal with every event separately. Routines should be established for:
  - where materials are stored
  - how materials are to be gathered and used
  - how groups are to be formed
  - how groups should work
  - clean-up procedures
  - format of written work, etc.
  - safe practices and procedures
  - student conduct.

4. Establish a Clear Sense of Purpose

- Be sure that the purpose of each lesson activity is understood before the activity is begun.
- Ensure that students follow through with assigned hands-on and written work.
- Establish a reasonable standard for written work.
- Provide frequent praise and reinforcement to students.
- Evaluate student learning frequently.

5. Provide Opportunities for Independent Thought and Expression

- Allow as much independent and small group work with materials as possible.
- Ask questions that encourage creative or higher levels of thinking rather than just the recall of information.
- When asking questions, allow time for students to think before asking for a response.
- Set tasks that allow more than one method of solution and encourage students to come up with their own approach.
- Use problem solving situations where the answer or solution is not evident or may have many solutions possible.
- Provide opportunities for individual or group projects.
- Use student ideas for designing classroom experiments and evaluating those experiments.
- Show interest in student questions and concerns.

6. Be Empathetic

- Encourage tolerance of different viewpoints.
- Help children relax and laugh off frustrations.
- Help students enjoy the wonder of science.
- Use puzzles, special poems, or stories to add variety.

E. FACILITIES AND MATERIALS ORGANIZATION

A science laboratory would be useful but not essential. While facilities with sinks, running water, growing stations, etc., are ideal, the program can be carried out in a regular classroom. Desks could be moved apart or together to form larger surface areas to work on if tables are not available. The out-of-doors can be used to show the application of what is being studied to the real world.

Organization of materials is an important factor in the success of any science program. Well organized materials can help make science teaching enjoyable; lack of organization leads to a wastage of time, materials and effort.

There are many approaches to organizing science materials. In many cases, organization strategies have been built into the learning resource materials themselves. Where the programs are accompanied by kits, many of the materials are provided and are packaged in a way that facilitates teaching of each unit. Where kits are not part of the program, the teaching materials generally include a listing of materials to facilitate planning and ordering but from this point the exact method or organization is left to the teacher and school.

In most cases, science materials must be organized at the school level as a cooperative staff effort. In some large school systems, a centralized system of distributing materials may be adopted but this is generally to support the schools own system of organizing materials rather than in place of it. Each school staff should thus establish its own guidelines

as to where materials are to be stored and what system(s) are to be used for their organization.

Refer to Appendix II for ideas for organization of materials.

F. OUTDOOR STUDIES

A Framework

Elementary science approached through the natural curiosity of students provides a unique opportunity for extending the classroom into the school yard, the neighbourhood and facilities, nearby fields, boulevards, museums, and natural or park areas. The outdoor classroom proves an effective and stimulating learning environment in which students can use the process skills in first-hand experiences to discover, observe, interpret, understand and appreciate things and processes of the real world around them.

Concrete experiences that involve seeing, touching and doing have their greatest potential for stimulating the growth of children's ability to think and learn when they are an integral part of an ongoing program, practiced in context with the concept areas. The ultimate goal of the experiential learning process is to develop environmentally alert individuals capable of making well-reasoned interpretations and motivated to taking responsibility for their decisions throughout life.

Division One

To be relevant to children who are at an age of learning primarily by doing rather than by watching and listening, a Division One science program should provide a variety of school year experiences to promote a sense of wonder about the world close at hand.

- Sensory awareness activities in the world outside the school serve as stimuli for developing basic skills in *observation*. The five senses are a young scientist's basic tools for discovering detail.
- A gravelled parking lot may be a medium for practicing techniques of grouping and *classifying* rocks as objects, according to their similarities and differences.
- *Measuring* shadows may be the starting point for developing the concept of change through the seasons.
- Recording data and *communicating* information are meaningful exercises when applied to practical observations such as an "adopted tree", a Ladybeetle search, or tracks in the snow.


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Division Two

Through direct interaction with biological, physical and social phenomena of the real world, the Division II science program should provide experiences for students to increase their ability to appreciate and apply the inquiry skills, enabling them to form impressions and develop concepts of the environment of which they are a part.

- *Observing*, *classifying*, *measuring* and *communicating* remain essential skills to be practiced and integrated into outdoor experiences. Implications for classroom teaching include the recognition that children's understanding of abstractions is generally preceded by an understanding of the concrete. Observing the diversity of organisms in a local slough is a step toward understanding the concept of systems as functioning units.
- An exploratory approach to learning is appropriate for using teachable moments, turning children's questions back to them, causing them to look again, to examine more closely, and thoughtfully *inferring* what happened in the light of conclusions drawn from all available evidence. A broken shell of a bird's egg is a clue to inferring several possible events. Shape and sizes of buildings or trees may be inferred from the shadows they cast.
- *Predicting* change is a practical and valuable activity for making connections between today and tomorrow, between cause and effect. Predictions about the effect of weather, wind or temperature, or insect activity may be made and later verified to confirm patterns of relationship.
- A study of micro-climates around the school yard provides for recognizing environmental factors and *controlling variables* to show their effect.
- *Interpreting data* is a logical follow through on activities where observations and measurements have been recorded as data. Plant or animal population counts, quadrat studies, or tallying and classifying schoolyard litter are sample activities from which to interpret data.
- In spring the daily observed increase in the pace of life provides opportunities for *defining operationally* the sun's effect as the ultimate source of energy. Freezing of water in the fall is an event which can be observed and tested, and the process operationally defined in terms of how it works.
- *Formulating hypotheses* is a spontaneously practiced skill with children who are eager to find explanations for the occurrence of very ordinary biological and physical phenomena in their surroundings. Connecting a snowy experience with the water cycle, explaining the presence of earthworms after a rain, or attracting birds to a feeding station are examples of using observations to assess and hypothesize on patterns of relationships.
- Many instances in daily living are in effect a type of *experimenting* and controlling variables. Defining problems, posing solutions,

taking actions to control certain events, and reflecting on the results are as basic to carrying out experimental procedures in science class as they are to planning how to spend a weekly allowance.

G. SAFETY

It is the responsibility of the teacher and the school to provide a safe working environment. It is important that the teacher implement safety procedures and guidelines. Elementary science activities provide opportunities to develop safety habits. With advance planning and awareness of possible unsafe situations, accidents may be avoided by controlling the danger or using appropriate safe procedures. By developing an awareness and understanding of safety, children will soon develop a positive attitude towards safety as a result of the safe practices and procedures being consciously followed.

Additional information on safety procedures and guidelines is found in Appendix IV.

H. EVALUATION PROCEDURES AND GUIDELINES

An effective evaluation program should serve several main purposes:

1. To indicate to students their relative success in the program.
2. To serve as a basis for planning and further instruction.
3. To provide information to parents and administrators.

<u>Some Principles of Evaluation</u>

1. Evaluation should be related to program objectives. A comprehensive evaluation program for elementary science should include measurement of proficiency in science process skills and attitudes as well as science knowledge.

2. Evaluation is a continuous process. Teachers and students need continuous feedback on the effectiveness of their efforts. If evaluation were to be done only occasionally, considerable time might be wasted in activities that are not appropriate.

3. Evaluation is a cooperative process. Evaluation should not be something that teachers do "to" students but rather something that is done "with" students. Students should be aware of the purpose of each activity they undertake and be involved in the evaluation of their own accomplishments and performance.

4. Effective evaluation will require a variety of approaches. The use of teacher-prepared paper and pencil tests is appropriate for measuring achievement of knowledge objectives but measurement of other objectives may require other techniques. A comprehensive evaluation program in science might include the following:

   a) written achievement tests;
   b) informal observations by the teacher;
   c) formal observation (use of checklists);
   d) anecdotal records;
   e) practical tests (lab tests);
   f) review of children's record books; and
   g) review of student's project work.

Suggestions for use of some of these techniques are given under separate headings below.

Achievement Tests

Achievement tests tend to be most effective at measuring student recall of program content. They are often less effective as measures of understanding of science processed, attitudinal growth and growth of psychomotor skills. For this reason paper and pencil tests should not be the only measure of student progress in science.

With this reservation in mind, an effective evaluation program will still likely consist, at least in part, of paper and pencil tests. Effective testing materials have been included in a number of the recommended resource materials. In particular each of the text programs has one or more means of evaluation, some of which are based on knowledge and vocabulary and some of which are criterion referenced to include tests of skills as well. In some of the resources, evaluation materials are provided which can serve as the basis for a weekly or at least monthly evaluation program.

Additional tests may be constructed by teachers to fill any gaps in available test materials.

Informal Observation

To provide for informal evaluation, the teacher must occasionally remove himself/herself from the role of director of classroom activities and instead, take on the role of observer. To do this, the teacher should take time to sit down with groups of students while they proceed "independently" with the task at hand, observing individual contributions to the group and observing the progress of the group as a whole. At these times, the teacher should be careful not to revert to the teacher-as-instructor role or students will not complete their tasks in their own way and the teacher will not have a true picture of how the students are thinking.

Through careful observation, the teacher may spot groups which are not functioning as well as they might. With experience, the teacher should be able to isolate the particular skills in need of improvement and take measures to improve them. In some cases, this can be done by merely asking a question to focus the attention of the group on something they have overlooked. In other cases, it may require a class discussion focusing on the relative success of different approaches used by the various groups.

Formal Observation

Skills which are of particular importance to watch for are:

i) science process skills;
ii) group skills.

In monitoring student proficiency or achievement in the process skills, the following checklist may be helpful. For further ideas on observation see:

Skill	- Check points (behaviours that are indicative of student's skill development.
Observing	- Shown patience and perseverance in making careful observations. - Uses a variety of sensory observations rather than just visual. - Recognizes subtle changes and distinctions between objects or events.
Classifying	- Identifies key differences between objects or events.
Measuring	- Uses measuring equipment in an appropriate way. - Measures accurately.
Communicating	- Interprets accurately information and instructions presented in writing. - Interprets accurately information and instructions presented orally. - Interprets accurately information presented in graphic or pictorial form. - Adequately communicates observations and findings orally. - Adequately communicates observations and findings in writing. - Adequately communicates observations and findings in graphic and pictorial form.

Communicating (Cont'd)	- Adequately participates in discussions of science activities.
Inferring	- Identifies relationships between events. - Makes wise use of prior knowledge in making inferences. - Maintains a questioning attitude rather than jumping to conclusions.
Predicting	- Recognizes factors that are involved in determining the course of events. - Can make reasonable predictions of future events based on available information.
Controlling Variables	- Recognizes variables within an experiment. - Takes account of each variable in designing and interpreting experiments.
Interpreting Data	- Can distinguish relevant from irrelevant data. - Can recognize a trend of events. - Can summarize the findings of an experiment.
Defining Operationally	- Can identify an object or event by simple tests. - Can describe how simple tests are used in identifying objects and events.

Group Work

Through careful observation, the teacher will be able to gauge individual and group success in completing assigned tasks. Where groups have difficulty completing tasks, the teacher may follow up by spot teaching or class discussion. Some specific problems and appropriate remedial teaching strategies are given in the following chart.

Strategies for Group Activities

Problem	Suggested Remedial Teaching Strategy
Members not listening to other members.	After each student makes an observation or suggestion, have another student repeat what was said, comment and add his own ideas.
Students not participating in the task.	At intervals, freeze the actions of the group and call on individuals to summarize the work of the group over the past five or ten minutes.
Stereotyping of roles with group. (e.g. one person always manipulating the materials, another student always the recorded.)	i) Shift membership in groups (usually best done between tasks rather than during tasks). ii) Suggest that students rotate roles for each day's activities.

CORRELATION CHARTS REFERENCING CORE TO TEXT

HOUGHTON MIFFLIN

GRADE ONE

Observing (O) Describing (D)
Investigating (I) Manipulating (M)
Organizing (Or) Quantifying (Q)
Generalizing (G) Applying (A)

UNIT	BIG IDEA	PART	LESSON CLUSTERS	CORE OR ELECTIVE	TOPIC	TIME Mins.	TIME Wks.	SKILLS Process & Psychomotor
1. Objects	There are structural patterns in all matter	A. Exploring	A-1	C	Examining Objects	60	1	O,D,Or,M
			A-2	C	Collecting & Sorting	90	2	O,D,I,Or,M
			A-3	C	Finding Properties	85	1	O,D,I,Or,M
			A-4	C	Grouping by Properties	95	1	O,D,M
		B. Observing	B-1	C	Using Your Senses	85	1	O,D,I,M
			B-2	C	Observing With Care	60	1	O,D,M
			B-3	E	Comparing Objects	65	1	O,D,M
2. Special Projects	There is order in space and time	A. Shapes	A-1	C	Shapes and Their Properties	70	1	O,D,M
			A-2	E	The Shapes of Objects	80	1	O,D,M
		B. Size	B-1	C	Comparing and Ordering	65	1	O,D,M
			B-2	C	Measuring	55	1	O,D,Or,M
		C. Position	C-1	C	Direction	70	1	O,D,M
			C-2	C	Distance	75	1	O,D,M
		D. Symmetry	D-1	E	Symmetry in Shapes	90	2	O,D,M
			D-2	E	Symmetry in Patterns	80	1	O,D,M
3. Changes	Changes and interaction are universal	A. Making Changes	A-1	C	Hand Changes	70	1	O,D,I,M,A
			A-2	C	Water Changes	65	1	O,D,I,M,A
			A-3	C	Heat Changes	60	1	O,D,M
			A-4	E	Changes in Position	65	1	O,D,M
		B. Familiar Changes	B-1	C	Order in Change	75	1	O,D,Or
			B-2	C	Time and Change	90	2	O,D,Or,M
		C. Changes Everywhere	C-1	C	Weather Changes	80	1	O,D,M
			C-2	E	You and Your Neighborhood	90	2	O,D,M

HOUGHTON MIFFLIN

GRADE ONE

Observing (O) | Describing (D)
Investigating (I) | Manipulating (M)
Organizing (Or) | Quantifying (Q)
Generalizing (G) | Applying (A)

UNIT	BIG IDEA	PART	LESSON CLUSTERS	CORE OR ELECTIVE	TOPIC	TIME Mins.	TIME Wks.	SKILLS Process & Psychomotor
4. Living Objects	Living objects change and interact	A. Let's Find Out	A-1	C	Familiar Objects	85	1	O,D,Or,M
			A-2	C	Mammals	70	1	O,D,Or
			A-3	C	Aquariums and Terrariums	65	1	O,D,M
		B. Properties	B-1	C	Living Objects Need Food	65	1	O,D,M,A
			B-2	C	Living Objects Have Young	70	1	O,D,M,A
			B-3	C	Growing Up	75	1	O,D,M,A,
			B-4	E	Objects Move	80	1	O,D,Or,I,M,A
			B-5	E	Responding	70	1	O,D,M,I,A
			B-6	C	People	120	2	O,D,Or,M

Core	Elective
26 weeks	14 weeks

HOUGHTON MIFFLIN

GRADE TWO

Observing (O) · Investigating (I) · Organizing (Or) · Generalizing (G)
Describing (D) · Manipulating (M) · Quantifying (Q) · Applying (A)

UNIT	BIG IDEA	PART	LESSON CLUSTERS	CORE OR ELECTIVE	TOPIC	TIME Mins.	TIME Wks.	SKILLS Process & Psychomotor
1. Properties of Matter	There are structural patterns in all matter	A. Solids	A-1	C	Finding Matter	110	1	O,D,Or,M,A
			A-2	C	Identifying Solids	75	1	D,I,M,A,
			A-3	C	Testing and Separating	85	1	O,I,M,D
			A-4	E	Comparing Solids	90	2	O,D,Or,I,M,A
		B. Liquids	B-1	C	Observing Liquids	75	1	O,D,I,M,A
			B-2	C	Testing and Comparing	85	1	O,D,I,M,A,
		C. Gases	C-1	C	Investigating Air	80	1	O,D,I,M,A
			C-2	E	Comparing Gases	60	1	O,D,I,A
2. Shapes and Surfaces	There is order in space and time	A. Shapes of Objects	A-1	C	Identifying Shapes	70	1	O,D,Or,M
			A-2	E	Describing Shapes	60	1	O,D,M,
			A-3	C	Inside and Outside	75	1	O,D,M
		B. Properties of Surfaces	B-1	E	Examining Surfaces	70	1	O,D,M
			B-2	E	Surface Friction	60	1	O,D,M
		C. Measuring Surfaces	C-1	C	Finding Surface Size	55	1	O,M
			C-2	C	Finding Size and Place	70	1	M,Q,D,O
			C-3	C	Finding Symmetry	55	1	O,D,M
3. Interacting Objects	Change and interaction are universal	A. Interaction	A-1	E	Objects Change	65	1	O,D,M
			A-2	C	Objects Interact	95	2	O,D,M
		B. Systems	B-1	C	Identifying Systems	65	1	O,D,M,I
			B-2	C	Examining Systems	70	1	O,D,I
			B-3	C	Making Systems	85	1	O,D,M
			B-4	E	Machines	65	1	O,D,M,I
		C. Interaction and Time	C-1	C	Comparing Times	95	2	O,D,M,I
			C-2	E	Timing Interactions	90	2	O,D,M,I

HOUGHTON MIFFLIN

GRADE TWO

Observing (O) Describing (D)
Investigating (I) Manipulating (M)
Organizing (Or) Quantifying (Q)
Generalizing (G) Applying (A)

UNIT	BIG IDEA	PART	LESSON CLUSTERS	CORE OR ELECTIVE	TOPIC	TIME Mins.	TIME Wks.	SKILLS Process & Psychomotor
4. Many of a Kind	Living objects change and interact	A. Populations	A-1	C	Groups of Living Things	50	1	O,D
			A-2	C	Trees and Birds	110	2	O,D,I,M
			A-3	C	Starting Populations	135	2	O,D,M
		B. Population Properties	B-1	E	Change in Number	65	1	O,D,M
			B-2	C	Homes for Animals	80	1	O,D,M
			B-3	C	Homes for Plants	75	1	O,D,M
			B-4	E	Homes for People	90	1	O,D,M
			B-5	E	Alike but Different	75	1	O,D,M

Core	Elective
25 weeks	15 weeks

HOUGHTON MIFFLIN

GRADE THREE

Observing (O) | Describing (D)
Investigating (I) | Manipulating (M)
Organizing (Or) | Quantifying (Q)
Generalizing (G) | Applying (A)

UNIT	BIG IDEA	PART	LESSON CLUSTERS	CORE OR ELECTIVE	TOPIC	TIME Mins.	TIME Wks.	SKILLS Process & Psychomotor
1. Variation	There are structural patterns in all matter	A. Variation in Objects	A-1	E	Sampling and Estimating	100	2	O,D,Q
			A-2	C	Grouping Objects	85	1	O,D,Or,A
			A-3	C	Variations in Groups	110	1	O,D,Or,A
			A-4	E	Describing Variation	105	1	O,D,Or,Q,A,I
		B. Variation in Matter	B-1	E	The Matter in Objects	105	2	O,D,I,A,
			B-2	C	Phases of Matter	95	1	O,D,A
		C. Variation in Interaction	C-1	E	Variation in Systems	110	2	O,D,Or,A,I
				E	Predicting	85	1	O,D,A,I
2. Space and Motion	There is order in space and time	A. Space	A-1	E	Space Everywhere	120	2	O,D,A
			A-2	C	The Space Inside	100	2	O,D,I,Q,A
		B. Position	B-1	C	A Place In Space	90	2	O,D,A
			B-2	C	Position Finders	140	2	D,A,I,M
			B-3	E	Position Patterns	110	2	O,D,A,I,G
		C. Motion	C-1	E	Investigating Motion	65	1	O,D,A,I,M
			C-2	E	Clues of Motion	95	1	O,D,A,I
			C-3	E	Describing Motion	75	1	O,D,I,M,A
3. Interaction and Energy	Change and interaction are universal	A. Interaction	A-1	E	Interaction and Systems	80	1	O,D,Or,A
			A-2	E	Variables in Systems	90	2	O,D,I,M,G,A
			A-3	E	Energy in Systems	80	1	O,D,Or,G,A
		B. Energy	B-1	C	Kinds of Energy	120	2	O,D,I,M,Or,G,A
			B-2	E	Making Energy Changes	85	1	O,D,I,M,Q,G,A
			B-3	E	Energy Chains	70	1	O,D,Or,M,A
		C. Looking for Energy	C-1	C	Finding Energy Givers	85	1	O,D,I,M,A,Q
			C-2	C	Mystery Movers	105	2	O,D,I,M,A,G
			C-3	C	Light Energy	145	2	O,D,Or,I,M,G,A

HOUGHTON MIFFLIN

GRADE THREE

Observing (O)
Investigating (I)
Organizing (Or)
Generalizing (G)

Describing (D)
Manipulating (M)
Quantifying (Q)
Applying (A)

UNIT	BIG IDEA	PART	LESSON CLUSTERS	CORE OR ELECTIVE	TOPIC	TIME Mins.	TIME Wks.	SKILLS Process & Psychomotor
4. Population Interactions	Living objects change and interact	A. Interaction Within A Population	A-1	C	Interactions	85	1	O,D,G,A,
			A-2	E	Home Building Interaction	120	2	O,D,G,A,I,M
			A-3	C	Young and Old Interact	120	2	O,D,I,Or,G,A
		B. Two Populations Interact	B-1	C	Plant-Eating Interactions	*180	2	O,D,I,Or,G,A
			B-2	C	Animal-Eating Interactions	*135	2	O,D,I,Or,Q,G,A
			B-3	C	After Organisms Die	*145	2	O,D,I,M,G
		C. Many Populations Interact	C-1	C	Food Chains	120	2	D,Or,G,A,
			C-2	C	Food Webs	130	2	O,D,M,Or,Q,G,A
			C-3	E	Communities	120	2	O,D,G,A,Or

*includes alternatives

Core	Elective
29 weeks	11 weeks

HOUGHTON MIFFLIN

GRADE FOUR

Observing (O)	Describing (D)
Investigating (I)	Manipulating (M)
Organizing (Or)	Quantifying (Q)
Generalizing (G)	Applying (A)

UNIT	BIG IDEA	PART	LESSON CLUSTERS	CORE OR ELECTIVE	TOPIC	TIME Mins.	TIME Wks.	SKILLS Process & Psychomotor
1. Environments	Living objects change and interact	A. Interactions in an Environment	A-1	C	What is an Environment	130	2	O,D,G,A
			A-2	C	Preparing for Later	170	2	M,Q,O,D,A
			A-3	C	Observing Factors	135	2	O,D,M,Q,G
		B. Populations Change Environments	B-1	C	Animals Cause Changes	110	1	O,D,I,M,G
			B-2	C	Plants Cause Changes	145	2	O,D,I,M,Q,G
			B-3	C	People Cause Changes	195	1	O,D,I,M,G,A
		C. Environments Change	C-1	E	Very Slow Changes	90	1	D,Q,A
			C-2	E	Sudden Changes	95	1	O,D,I,M,Or
			C-3	E	Regular Changes	100	1	D,Q,G,A
2. Exploring Matter	There are structural patterns in all matter	A. Properties of Matter	A-1	E	Kinds of Matter	130	1	O,D,M,Q,G,A
			A-2	C	Phases of Matter	110	1	O,D,I,M,G,A
			A-3	E	Arrangement of Matter	110	1	O,D,I,M,A
		B. Earth Matter	B-1	E	Looking at Layers	90	1	O,D,Q,G,A
			B-2	E	Looking Inside Rocks	120	1	O,D,Or,G,M,A
		C. Matter and Light	C-1	C	Light Through Matter	145	2	O,D,I,M,G,A
			C-2	C	Looking Through Lenses	135	2	O,D,I,M,Q,A
3. Patterns	There is order in space and time	A. Recognizing Patterns	A-1	E	What is a Pattern	155	2	O,D,I,M,Q,A
			A-2	E	Patterns Tell Stories	140	2	O,D,I,Or,G,A
			A-3	E	Patterns and Predictions	140	2	O,Or,J,Q,M,D, A,G
		B. Patterns of Structure	B-1	E	Patterns of Support	125	1	O,M,G,A,D
			B-2	E	Patterns of Balance	155	2	O,M,G,A,Or
		C. Patterns that Repeat	C-1	C	All Sorts of Cycles	195	2	I,D,M,O,Q,A,D
			C-2	C	The Water Cycle	170	2	O,D,G,I,A

Core - 25 weeks
Elective - 14 weeks

HOUGHTON MIFFLIN

GRADE FOUR

Observing (O)
Investigating (I)
Organizing (Or)
Generalizing (G)
Describing (D)
Manipulating (M)
Quantifying (Q)
Applying (A)

UNIT	BIG IDEA	PART	LESSON CLUSTERS	CORE OR ELECTIVE	TOPIC	TIME Mins.	TIME Wks.	SKILLS Process & Psychomotor
4. Exploring Energy		A. Sound Energy	A-1	C	What is Energy	90	1	D,Or,A
			A-2	C	Interaction and Sound	85	1	O,D,I,M,A
			A-3	C	Sound Transfer	90	1	O,D,I,M,Q,G,A
			A-4	C	Sound Variables	90	1	O,D,I,M,Or,Q,A
		B. Heat Energy	B-1	E	Heat Transfer	175	2	O,D,I,M,Q,Or,A
			B-2	E	Heat Variables	100	1	O,D,I,M,Q,G,A
		C. Electric Energy	C-1	C	Transfer of Electricity	90	1	O,D,I,M,Or,D,A,G
			C-2	C	Variables in Circuits	90	1	O,D,I,M,Or,D,G
			C-3	E	More About Energy Transfer	90	1	O,D,I,M,A

HOUGHTON MIFFLIN

GRADE FIVE

Observing (O) Describing (D)
Investigating (I) Manipulating (M)
Organizing (Or) Quantifying (Q)
Generalizing (G) Applying (A)

UNIT	BIG IDEA	PART	LESSON CLUSTERS	CORE OR ELECTIVE	TOPIC	TIME Mins.	TIME Wks.	SKILLS Process & Psychomotor
1. Adaptations	Living objects change and interact	A. Outside Adaptations	A-1	C	Protective Adaptations	*210	3	O,D,Or,Q,G,A
			A-2	C	Getting Food	180	3	O,D,I,Or,G,A
		B. Inside Adaptations	B-1	E	Systems	*190	3	O,D,I,M,Or,A
			B-2	E	Cells	135	2	O,D,I,Or,A
		C. Behavioral Adaptations	C-1		Animal Behavior	*190	2	O,D,M,G,I,Q,A
			C-2	C	Plant Behavior	*180	2	O,D,M,G,I,Or
		D. Adaptations of Life Stages	D-1		Animal Stages	*185	2	O,D,I,M,G,A
			D-2	C	Plant Stages	170	2	O,D,I,M,Or,G,Q,A
2. Forces	There are structural patterns in all matter	A. Forces In Action	A-1	E	Identifying Forces	120	1	O,D,I,M,A,G
			A-2	E	Measuring Forces	195	3	O,D,M,Q,G
		B. Liquids and Gases	B-1	E	Forces in Liquids	200	3	O,D,I,M,Or,G,Q,A
			B-2	E	Forces in Gases	180	3	O,D,I,M,Or,G,Q,A
			B-3	E	Volume	200	3	O,D,I,M,Or,G,Q,A
		C. Simple Machines	C-1	E	Putting Forces to Work	190	3	O,D,I,M,Or,G,Q,A
			C-2	E	Work With Inclined Planes	190	3	O,D,I,M,Or,G,Q,A
			C-3	E	Levers	160	2	O,D,I,M,Or,Q,A

HOUGHTON MIFFLIN

GRADE FIVE

Observing (O) Describing (D)
Investigating (I) Manipulating (M)
Organizing (Or) Quantifying (Q)
Generalizing (G) Applying (A)

UNIT	BIG IDEA	PART	LESSON CLUSTERS	CORE OR ELECTIVE	TOPIC	TIME Mins.	TIME Wks.	SKILLS Process & Psychomotor
3. Motion	There is order in space and time	A. Relative Motion	A-1	E	Objects in Motion	135	2	O,D,M,Or,A
			A-2	E	Records of Motion	175	2	O,D,I,M,Or,G, A (*inferring)
			A-3	E	Circular and Rotary Motion	*140	2	O,D,I,M,G,A
		B. Describing Position	B-1	C	Reference Frames	*150	2	O,D,M,Q
			B-2	C	Using Numbered Circles	125	2	O,D,Q,G,A
			B-3	C	Using Numbered Lines	175	2	O,D,Or,Q,G,M
		C. Changing Direction	C-1	E	Moving Air & Flying Objects	*210	3	O,D,I,M,G,A,Q
			C-2	E	Simple Machines	*175	2	O,D,I,M,G,A
			C-3	E	Motion and Machines	170	1	O,D,I,M,Or,G, A,Q
4. Matter and Energy	Change and interaction	A. Transfer of Energy	A-1	C	Conduction and Convection	*200	2	O,D,I,M,G,A
			A-2	E	Wave Motion	195	3	O,D,I,M,G
		B. Changes in Matter	B-1	E	Changes in Motion	170	2	O,D,Or,I,M,G,Q
			B-2	E	Changes in Temperature	170	2	O,D,M,I,G,A
			B-3	E	Changes in Phase	110	1	O,D,I,M,Or,A
		C. Changes in Systems	C-1	E	Systems, Matter, and Change	*170	2	O,D,I,M,Or,G
			C-2	C	Changes in Acids and Bases	*240	2	O,D,I,M,Or,G
			C-3	C	Chemical and Physical Changes	*160	2	O,D,I,M,G,A

Core - 26 weeks
Elective - 14 weeks

HOUGHTON MIFFLIN

GRADE SIX

Observing (O) | Describing (D)
Investigating (I) | Manipulating (M)
Organizing (Or) | Quantifying (Q)
Generalizing (G) | Applying (A)

UNIT	BIG IDEA	PART	LESSON CLUSTERS	CORE OR ELECTIVE	TOPIC	TIME Mins.	TIME Wks.	SKILLS Process & Psychomotor
1. Population Needs	Living objects change and interact	A. Population Growth and Food	A-1	C	Producers and Consumers	*150	1	O,D,I,A,Or,G,Q
			A-2	E	What Have We Taken	*255	3	I,A,M,Or,G,Q
			A-3	E	Population Growth Rate	*155	2	D,Q,G,A,Or
		B. Population Success	B-1	E	Successful and Unsuccesful Populations	*210	2	O,D,I,M,Q,G,A
			B-2	E	The World of Reptiles	*145	1	O,D,M,G,Or,A
			B-3	E	The World of Plants	120	1	O,D,I,M,A
		C. Fuels for Populations	C-1	E	Fuels	130	2	O,D,I,M,A,Or, Q,G
			C-2	E	Food is Fuel for People	105	1	D,Or,Q,G,A
			C-3	E	Putting it all Together	110	1	D,Q,A,G
2. Models	There is order in space and time	A. The Model World	A-1	E	What is a Model	*90	1	O,D,I,G,M
			A-2	E	Ideal Models	*100	1	D,M,G,A
			A-3	E	Scale Models	*130	1	O,D,M,Q,A
			A-4	E	Models of Earth and Sky	95	1	O,D,M,Q
		B. Models of Systems	B-1	E	Models of Interaction	120	2	O,D,I,M,Or,A
			B-2	E	Models of Past and Present	*130	1	O,D,Or,G,I,A
			B-3	E	Simulation Models	*125	1	O,D,I,M,Or,G
		C. Using Models	C-1	E	Predicting From Models	100	1	O,D,I,G,A
			C-2	E	Models of Human Communication	130	1	O,I,M,Or,Q
			C-3	E	Models of Earthquakes and Volcanoes	110	1	O,D,I,M,A

HOUGHTON MIFFLIN

GRADE SIX

Observing (O)
Investigating (I)
Organizing (Or)
Generalizing (G)
Describing (D)
Manipulating (M)
Quantifying (Q)
Applying (A)

UNIT	BIG IDEA	PART	LESSON CLUSTERS	CORE OR ELECTIVE	TOPIC	TIME Mins.	TIME Wks.	SKILLS Process & Psychomotor
3. Models of Matter	There are structural patterns in all matter	A. More Than One Model	A-1	C	Inferring From Models	140	2	O,M,I,Or,G,A
			A-2	C	Models of Mixing Systems	*225	2	O,D,I,M,A
			A-3	C	Models of Mixing and Unmixing	190	2	O,D,I,Or,G,A
		B. The Small Particle Model	B-1	C	What is the Small Particle Model	210	1	O,D,I,Or,G,A
			B-2	C	Heat Affects Matter	100	1	O,D,I,A
			B-3	C	Solids, Liquids & Gases	185	2	O,D,I,Q,A
			B-4	C	Surface Properties	180	1	O,I,A,Q
		C. Models Must Be Tested	C-1	C	Liquids and Gases Flow	200	2	O,I,M,G,A,Or
			C-2	C	Gases Interact with Liquids	*185	2	O,I,G,A
			C-3	E	Scientists and Models	*125	1	O,D,M,G,Q,A
4. Energy and Ecosystems	Change and interaction are universal	A. Observing Ecosystems	A-1	C	Ecosystems	*160	2	O,D,I,Q,A
			A-2	C	Interactions in Ecosystems	130	2	O,D,G,A
			A-3	E	People Change the Face of the Earth	150	2	O,D,G,A,Or
		B. Resources and Problems	B-1	C	Conserving Resources	140	1	O,D,Or,G,A,I
			B-2	C	Everything Goes Someplace	160	2	O,D,I,G,Or,A
			B-3	C	Our Part in the Pollution Problem	120	1	O,D,A,I,Q,G
		C. Using Energy Wisely	C-1	E	Using Electricity	120	1	O,D,I,Q,G,A
			C-2	C	Energy Sources and Problems	155	2	O,D,Or,I,Q,G,A
			C-3	C	Making Choices	90	1	D,G,A

Core - 27 weeks
Elective - 13

- No section on magnetism, light or weather.

ADDISON WESLEY

GRADE 1:

CHAPTERS	TOPIC	CORE OR ELECTIVE	PROCESS	APPROX. TIME
1	Animals	C	Observing* Classifying* Communicating	3-4 weeks (5 lessons)
2	Plants	C	Communicating Classifying Observing* (Inferring)	4 weeks (6 lessons)
3	Distance	C	Measuring* Observing Communicating (Inferring)*	2-3 weeks (5 lessons)
5	Order	C	Classifying* Observing Communicating (Inferring)	1½ weeks (2 lessons)
7	Calendar Times	C	Classifying (Inferring)	1 week (3 lessons)
9	Solids	C	Classifying* Observing Measuring Communicating (Inferring)	3 weeks (6 lessons)
10	Liquids	C	Observing* Communicating	1½ weeks (3 lessons)
11	Air	C	Communicating Observing*	1 week (2 lessons)

NOTE: It is recommended that teachers do the "Enrichment Activities" suggested for all core chapters, particularly if the core time allocation is under 24 weeks.

- Gr. 3, emphasize communities as interacting populations.

ADDISON-WESLEY

GRADE 1:

CHAPTERS	TOPIC	CORE OR ELECTIVE	PROCESS	APPROX. TIME
4	Space	E	Predicting Inferring Observing	1½ weeks (2 lessons)
6	Short Time-Long Time	E	Predicting Inferring	1 week (2 lessons)
8	Moving Things	E	Communicating Predicting Inferring Classifying	1½ weeks (3 lessons)
12	Soil	C	Communicating Classifying Inferring Measuring	1 week (3 lessons)
13	Where is "away"	E	Communicating Inferring	1 week (1 lesson)

Core - 20 weeks
Elective - 20 weeks

ADDISON-WESLEY

GRADE 2:

CHAPTERS	TOPIC	CORE OR ELECTIVE	PROCESS	APPROX. TIME
1	Seeds	C	Identifying Classifying* Observing Communicating* Use Numbers Describe	4 weeks (6 lessons)
2	Getting Ready	C	Describe Inferring Identifying Communicating*	2 weeks (3 lessons)
3	Standard Units	C	Measuring* Communicating Demonstrating Use Numbers	1½ weeks (3 lessons)
4	What Is Time	C	Classifying Describing* Inferring* Constructing Measuring Predicting	2-3 weeks (5 lessons)
5	Measuring Time		Observing* Describing Inferring Identifying	1 week (2 lessons)
6	Making Things Move	C	Demonstrating Identifying Inferring* Classifying Observing*	3-4 weeks (5 lessons)
7	Kinds of Matter	C	Identifying Classifying Communicating*	2 weeks (2 lessons)
8	Particles	E	Observing Inferring	2 weeks (2 lessons)

ADDISON-WESLEY

GRADE 2:

CHAPTERS	TOPIC	CORE OR ELECTIVE	PROCESS	APPROX. TIME
9	Changes In Matter	C	Classifying Inferring* Observing Communicating	2 weeks (3 lessons)
10	Animals In Spring	C	Observing* Outdoor? Inferring* Naming Communicating	2 weeks (3 lessons)
11	Plants In Spring	C	Identifying Describing Inferring* Observing* Communicating Classifying	2 weeks (3 lessons)
12	Doing Your Part	E	Observing Communicating Interpreting	2 weeks (2 lessons)

Core - 23.5 weeks
Elective- 16.5 weeks

GRADE 3:

CHAPTERS	TOPIC	CORE OR ELECTIVE	PROCESS	APPROX. TIME
1	Communities of Living Things	C	Inferring Collecting Observing* Experimenting Describing Communicating*	6 weeks (6 lessons)
2	Measurement	C	Measuring* Psychomotor skills Observing Following directions Describing Constructing Recording*	5-6 weeks (5 lessons)
3	Motion & Location	C	Observing Inferring* Describing* Communicating Grid (ordered pairs)	3 weeks (4 lessons)
4	Air - An Invisible Push	C	Observing Demonstrating Experimenting Describing	3 weeks (4 lessons)
5	Bones & Muscles	E	Inferring Observing Identifying Describing	3 weeks (3 lessons)
6	Shadows & Light	C	Experimenting Predicting Inferring Intro. Variables Drawing Conclusions	2 weeks (4 lessons)

ADDISON-WESLEY

GRADE 3:

CHAPTERS	TOPIC	CORE OR ELECTIVE	PROCESS	APPROX. TIME
7	Sunlight on the Earth & Moon	E	Interpreting Inferring Communicating Identifying Recording	3 weeks (5 lessons)
8	Heat & Temperature	C	Measuring Communicating Observing Experimenting Constructing Predicting Interpreting data Drawing Conclusions	6 weeks (5 lessons)
9	It All Depends	E	Classifying Communicating Experimenting Describing Inferring	3 weeks (lesson 3)

Core - 26 weeks
Elective - 14 weeks

ADDISON-WESLEY

GRADE 4:

CHAPTERS	TOPIC	CORE OR ELECTIVE	PROCESS	APPROX. TIME
1	Life Cycles	C	Identifying Describing Observing* Memorizing Communicating*	4 weeks (4 lessons)
2	Water & the Land	C	Measuring Classifying Describing Predicting Inferring Observing Comparing Communicating	3-4 weeks (6 lessons)
3	Electric Light Circuits	C	Demonstrating Inferring Experimenting Controlling Variables Predicting Communicating Observing	6 weeks (6 lessons)
4	Cells, Tissues & Your Body	E	Observing Identifying Comparing Classifying	3 weeks (6 lessons)
5	Sliding, Rolling & Friction	E	Describing Experimenting Comparing Observing Drawing Conclusions Classifying Predicting Identifying Inferring Demonstrating	6 weeks (6 lessons)

ADDISON-WESLEY

GRADE 4:

CHAPTERS	TOPIC	CORE OR ELECTIVE	PROCESS	APPROX. TIME
6	The Air Around Us	C	Comparing Predicting* Constructing Formulating Models Measuring Observing Describing Inferring* Experimenting*	6 weeks (6 lessons)
7	Stars - Night & Day	E	Predicting Interpreting data Observing Comparing	3 weeks (4 lessons)
8	Vibrations & Sounds	C	Observing Demonstrating Communicating Experimenting Constructing Inferring Interpreting	5 weeks (5 lessons)
9	Ocean & Fresh Water Environments	C	Observing Inferring Recording Describing Comparing Identifying Experimenting Formulating Model	4 weeks (5 lessons)

Core - 26 weeks
Elective - 14 weeks

ADDISON-WESLEY

GRADE 5:

CHAPTERS	TOPIC	CORE OR ELECTIVE	PROCESS	APPROX. TIME
1	Classifying Living Things	C	Classifying* Communicating Describing	4 weeks (6 lessons)
2	Rocks in Layers	E	Predicting Observing Describing Inferring Conclusions	4 weeks (5 lessons)
3	Changes In Matter (omit emphasis on atoms and molecules)	C	Observing Identifying Measuring Classifying	4 weeks (5 lessons)
4	Your Nutrition & Other Needs	E	Identifying Experimenting Describing Measuring Communicating	4 weeks (4 lessons)
5	Magnets & Their Uses	C	Classifying Predicting Describing Interpreting Demonstrating Experimenting (some)* Communicating Constructing	3 weeks (4 lessons)
6	Winds & Convection	C	Observing Experimenting Predicting Describing Communicating Constructing Measuring	4-5 weeks (6 lessons)

ADDISON-WESLEY

GRADE 5:

CHAPTERS	TOPIC	CORE OR ELECTIVE	PROCESS	APPROX. TIME
7	Paths of Light	C	Observing Constructing Experimenting* Inferring Predicting* Identify	3 WEEKS (4 lessons)
8	Forces and Motion	E	Experimenting Observing Communicating Describing Comparing Predicting	6 weeks (6 lessons)
9	Moon - Our Nearest Neighbour	E	Listing (Communicating) Calculating Constructing Describing Predicting Inferring	3 weeks (5 lessons)
10	Interdependence of Living Things	C	List - Record Identifying Observing Ordering Communicating Inferring Conclusions	4 weeks 6 lessons

Core - 23 weeks
Elective - 17 weeks

ADDISON-WESLEY

GRADE 6:

CHAPTERS	TOPIC	CORE OR ELECTIVE	PROCESS	APPROX. TIME
1	Changing & Preserving Our Environment	C	Predicting Ordering Communicating Experimenting Measuring Formulating models Inferring Drawing Conclusions	4-5 weeks (5 lessons)
2	Water In the Air	C	Measuring Recording Experimenting Inferring Observing Communicating Classifying	6 weeks (7 lessons)
3	Images and Refraction	C	Experimenting Conclusions Constructing Inferring Observing Communicating	4 weeks (5 lessons)
4	The Earth in Space	E	Record Observing Formulating models Inferring	3 weeks (5 lessons)
5	Electric Charges & Currents	C	Experimenting* Predicting Recording Observing Constructing* Drawing Conclusions	5 weeks (5 lessons)

ADDISON-WESLEY

GRADE 6:

CHAPTERS	TOPIC	CORE OR ELECTIVE	PROCESS	APPROX. TIME
6	Using Forces	E	Identifying Measuring Calculating Constructing Conclusions	2 weeks (4 lessons)
7	Changes In the Land	E	Acquisition of Information Notetaking	3 weeks (5 lessons)
8	Living Things - Continuity and Change	E	Experimenting Comparing Predicting Reading	4 weeks (5 lessons)
9	Populations	C	Collect Data Interpreting Data Conclusions	2 weeks (4 lessons)
10	Energy and Energy Problems	C	Measuring Conclusions Experimenting Interpreting	4 weeks (4 lessons)

Core - 26 weeks
Elective - 14 weeks

GRADE 1

EXPLORING SCIENCE

CORE OR ELECTIVE	LESSON CLUSTER	SPECIFIC TOPIC	TIME/WEEKS	PROCESS SKILLS	PSYC. MOTOR
Core	Unit 1	Senses (Properties of objects)	5 weeks	Observation, Inferring, Predicting, Comparing, Communicating	
Core	Unit 2	Living things	6 weeks	Observing, Classifying, Inferring, Predicting, Comparing, Communicating, Experimenting	
Core	Unit 3	Sorting	5 weeks	Observing, Classifying, Comparing, Communicating, Interpreting Data	
Core	Unit 6	Spaces and places	6 weeks	Inferring, Predicting, Observing, Classifying, Communicating, Spatial Relations, Experimenting	Operating individual body members
*Elective	Unit 4	Light and Shadow (Energy and Time)	4 weeks	Predicting, Observing, Inferring, Communicating, Spatial Relations, Experimenting, Comparing	Eye-foot coordination Eye-hand coordination
Elective	Unit 5	Time	6 weeks	Inferring, Observing, Measuring, Predicting, Communicating, Comparing Using Members, Interpreting Data	Drawing and coloring (making a drawing of an idea) Reading a clock

*N[illegible] recommended for Grade 1

Core - 24 weeks

EXPLORING SCIENCE

CORE OR ELECTIVE	LESSON CLUSTER	SPECIFIC TOPIC	TIME/WEEKS	PROCESS SKILLS	ATTITUDES AND PSYC. MOTOR
Core	Unit 1	Food for Animals and You (Living Things & Energy) (Ecological Relation-ships)	6 weeks	Inferring, Observing, Classifying, Collecting Data, Comparing, Interpreting Data	Eye-hand - cutting pictures Eye-hand - drawing
Core	Unit 2	Environment (Weather, Time, Air, Change)	6 weeks	Observing, Collecting Data, Infer-ring, Classifying, Comparing, Spatial Relations, Communicating, Interpreting Data, Experimenting	- Awareness - Responsibility value - Drawing a circle - Hand-eye coordi-nation
Core	Unit 3	Measuring (Measurement, standard units)	7 weeks	Inferring, Predicting, Comparing, Observing, Using Numbers, Collecting Data, Measuring, Communicating, Classifying	- Value - Measuring - one after the other, ordering
Core	Unit 4	Magnets Properties, kinds, uses	5 weeks	Classifying, Observing, Predicting, Comparing, Interpreting Data, Infer-ring, Experimenting	Hand-eye coordina-tion
Elective	Unit 5	The Moon (time, shapes of the moon)	4 weeks	Observing, Inferring, Spatial Rela-tions, Classifying, Predicting, Collecting Data, Comparing, Interpreting Data, Communicating	Drawing Number in order
Elective	Unit 6	Rocks and Soils (Change, time)	5 weeks	Comparing, Observing, Classifying, Experimenting, Predicting, Inferring	Value

Core - 24 weeks
Elective - 16 weeks

GRADE 3

EXPLORING SCIENCE

CORE OR ELECTIVE	LESSON CLUSTER	SPECIFIC TOPIC	TIME/WEEKS	PROCESS SKILLS	ATTITUDES AND PSYC. MOTOR
Core	Unit 1	Seed Plants (Environment needs of plants, parts of seeds and plants and their roles in adaptation)	8 weeks	Observing, Comparing, Inferring, Communicating, Experimenting	Beauty, Importance of seed plants (value), Fine motor skills (cutting, drawing)
Core	Unit 2	Animal Behavior (Environment and behavior interdepending in an environment	7 weeks	Observing, Inferring, Collecting Data, Predicting, Comparing, Communicating, Hypothesizing, Classifying, Interpreting Data, Experimenting	
Core	Unit 3	Heat and Temperature (Energy, measuring temperature, behavior of gases, change of state, insulation, conduction)	7 weeks	Observing, Comparing, Inferring, Communicating, Measuring, Predicting	
Elective	Unit 4	Sounds Around You (How sounds are alike and travel, hearing sounds, animal sounds & hearing, sources of sound)	6 weeks	Observing, Communicating, Inferring, Hypothesizing, Collecting Data, Comparing, Predicting	
Elective	Unit 5	Water in Your Environment. Importance of water, uses of water, sources of water, water cycle, water purification	5 weeks	Observing, Comparing, Inferring, Hypothesizing	Value
Core	Unit 6	Location, Motion and Force NOTE: Section on "Location" is core.	2 weeks	Communicating, Classifying, Spatial Relations, Interpreting Data, Observing, Experimenting, Measuring, Predicting	Value

Core - 24 weeks

EXPLORING SCIENCE

CORE OR ELECTIVE	LESSON CLUSTER	SPECIFIC TOPIC	TIME/WEEKS	PROCESS SKILLS	ATTITUDES AND PSYC. MOTOR
Core	Unit 1	Plant Growth & Behavior Cell structure, plant needs, (tropism), interdependence	7 weeks	Observing, Comparing, Communicating, Classifying, Experimenting, Inferring, Predicting	
Core	Unit 2	Animals & Their Environment Habitation & adaptation Population, Conservation	8 weeks	Observing, Communicating, Comparing, Using Numbers, Inferring	Value
Elective	Unit 3	Work & Machines, Force & Energy, gravity energy conservation	6 weeks	Observing, Comparing, Measuring, Inferring, Interpreting Data, Experimenting	Value
Core	Unit 4	Solids, Liquids & Gases Molecules, molecular motion, change of state, chemical change NOTE: de-emphasize sections on atoms and molecules	5 weeks	Measuring, Observing, Comparing, Hypothesizing, Communicating, Inferring, Collecting Data, Predicting, Classifying	
Core	Unit 5	Air & Weather Air pressure (force) mass, water cycle, humidity, weather prediction	6 weeks	Observing, Inferring, Comparing, Predicting, Measuring, Collecting Data	Value
Elective	Unit 6	Watching The Sky (Solar System) energy, telling time	5 weeks	Observing, Comparing, Inferring, Using Spatial Relations, Using Numbers, Communicating, Predicting	Value

Core - 26 weeks
Elective - 14 weeks

GRADE 5

EXPLORING SCIENCE

CORE OR ELECTIVE	LESSON CLUSTER	SPECIFIC TOPIC	TIME/WEEKS	PROCESS SKILLS	ATTITUDES AND PSYC. MOTOR
Elective	Unit 1	Small Living Things Food chain *(Potential harmful bacteria e.g. p. 13) Habitats	7 weeks	Observing, Comparing, Communicating, Inferring	Safety, Value
Elective	Unit 2	Your Body Cells, tissues, organs, phyrological processes, health, nutrition	6 weeks	Observing, Communicating, Using Numbers, Measuring, Collecting Data, Comparing, Inferring	Health
Core	Unit 3	Electricity Static, current, energy, chemical energy, circuits, energy conversion, magnetism, electrical communication	6 weeks	Observing, Inferring, Communicating, Predicting, Comparing, Collecting Data, Interpreting Data	Safety, Value
Core	Unit 4	Light Propagation, refraction, reflection, color, vision	5 weeks	Observing, Comparing, Inferring, Communicating, Measuring, Collecting Data, Interpreting Data	
Core	Unit 5	The changing land-causes of land change, erosion, reduction, chemical & mechanical change, minerals, fossils, soil, interaction of living & non-living things, fossil energy, conservation recycle	7 weeks	Observing, Communicating, Predicting, Comparing, Experimenting, Inferring, Classifying	Value
Core	Unit 6	Mapping the Earth* Migration, properties of magnet, weather, kinds of maps, symbols, scales NOTE: decrease emphasis on "Mapping the Earth".	6 weeks	Observing, Communicating, Interpreting Interdisciplinary Data, Spatial Relations, Inferring, Measuring, Using Numbers, Comparing, Predicting	

Core - 24 weeks

EXPLORING SCIENCE

CORE OR ELECTIVE	LESSON CLUSTER	SPECIFIC TOPIC	TIME/WEEKS	PROCESS SKILLS	ATTITUDES AND PSYC. MOTOR
Elective	Unit 1	Interacting with Your Environment Human senses & narrow systems adapting, reflexive behavior, learned behavior	5 weeks	Observing, Collecting Data, Comparing, Inferring, Communicating	Value
Core	Unit 2	Plant & Animal Life Cycles Reproduction, cell behavior, growth, metamorphons	7 weeks	Observing, Communicating, Inferring, Comparing	Safety, cutting with a knife
Core	Unit 3	Matter and You Properties of matter, inertia, gravity, molecules & atoms, elements, compounds, mixtures. NOTE: decrease emphasis on molecules, inertia & gravity	3 weeks	Observing, Inferring, Measuring, Predicting, Communicating, Comparing, Hypothesizing, Classifying	
Core	Unit 4	Changes in Energy Kinds of Energy	6 weeks	Measuring, Observing, Inferring, Experimenting, Communicating, Predicting, Hypothesizing, Comparing	
Elective	Unit 5	Earth in Space Solar system, comets, asteroids, meteors, meteorites, telescopes, sun	4 weeks	Measuring, Comparing, Communicating, Inferring, Predicting, Observing, Experimenting	
Core	Unit 6	Ecosystem Earth Interaction - living, nonliving, social systems, cycles (H_2O, O_2, H), solar energy, interdependency (living, nonliving), food webs	6 weeks	Predicting, Experimenting, Observing, Inferring, Communicating, Comparing, Hypothesizing	Value

Core - 22 weeks
Elective - 18 weeks

APPENDICES

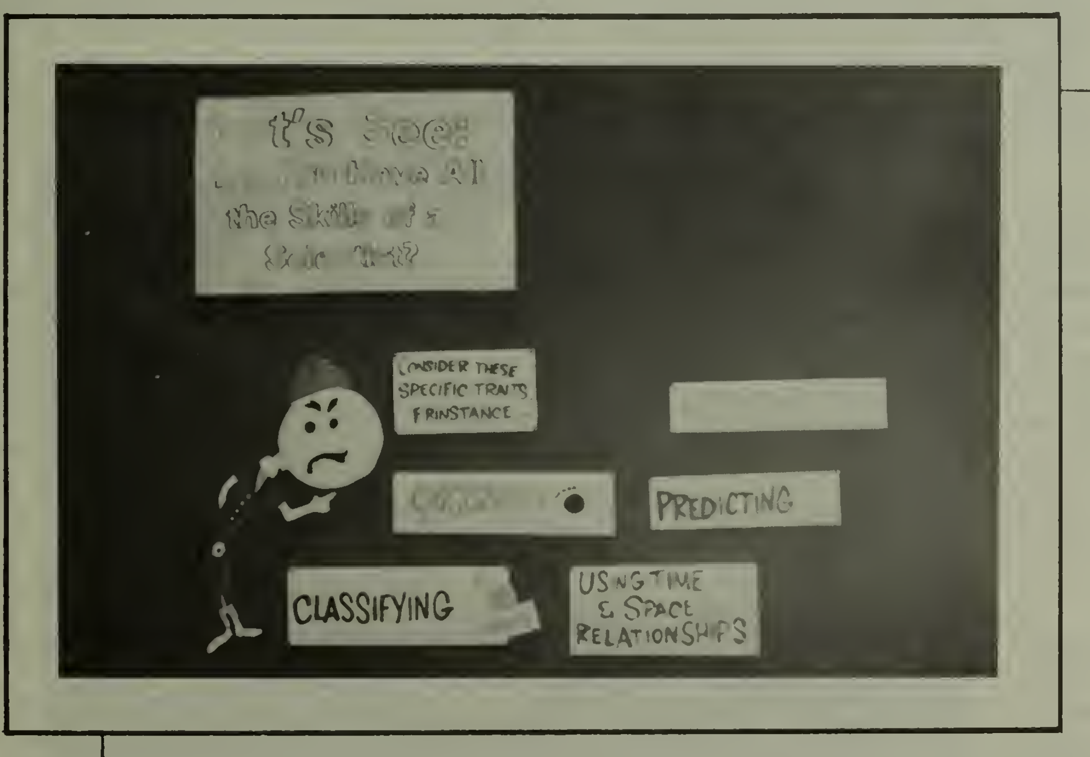
APPENDIX I

THE PROCESS SKILLS

OBSERVING

The process of observation is perhaps the most basic inquiry skill. The child, almost from birth, develops his ability to use the five senses to gain information about objects and events in his immediate environment. Constantly bombarded with perceptual information, the child learns to organize and assimilate information about himself, others and his immediate environment. His reliance on observations also influences the child's conception of things about him.

It is essential that the child develop his skills in observing through first-hand experiences. Given a variety of objects, the child used his five senses to obtain information about the object: its colour, shape, texture, smell, taste, sound it makes when dropped, whether it is heavy or light when compared to other objects, whether it is warm or cold. Early experiences in observation should deal with the properties of objects in the child's environment. In addition, the child should describe the various properties of an object verbally and later in written form. In the early school years, the teacher plays a role in providing the child with a variety of objects and materials to practise observation and in describing those observations in precise terms.



Observations identify those characteristics or properties that are directly perceived through the senses. As such, observing requires physical manipulation of the object(s) or materials as well as smelling, hearing and touching for sensory information. Field trips should be utilized to extend the awareness of objects both in the natural and man-made environments.

Since observation provides the basis for making predictions, inferences and hypotheses, care must be taken to ensure a proficiency in the skill during the primary grades. Experiences in observation are greatly enhanced through outdoor nature walks and in the examination of interesting objects brought to school by both pupil and teacher.

As the child handles and manipulates a variety of objects during the early years, he also sets the stage for making quantitative observations. That is, he observes that some objects are lighter or heavier, larger or smaller, or warmer or colder when compared to other objects. The comparison is relative to the other object, or to a standard unit. Ample opportunity and experience should be provided in kindergarten and grade one to make relative comparisons. The child should express or describe the quantitative differences (size, mass, temperature) between objects with a vocabulary of descriptive words and phrases. Having made comparative observations between objects, the child begins to lay the foundation for the development of another important skill for obtaining data - the skill of measurement. Through the observation period of visually examining and physically manipulating objects, the primary student begins to become more accurate in his comparisons through the use of standard units. This marks the early stages of measurement.

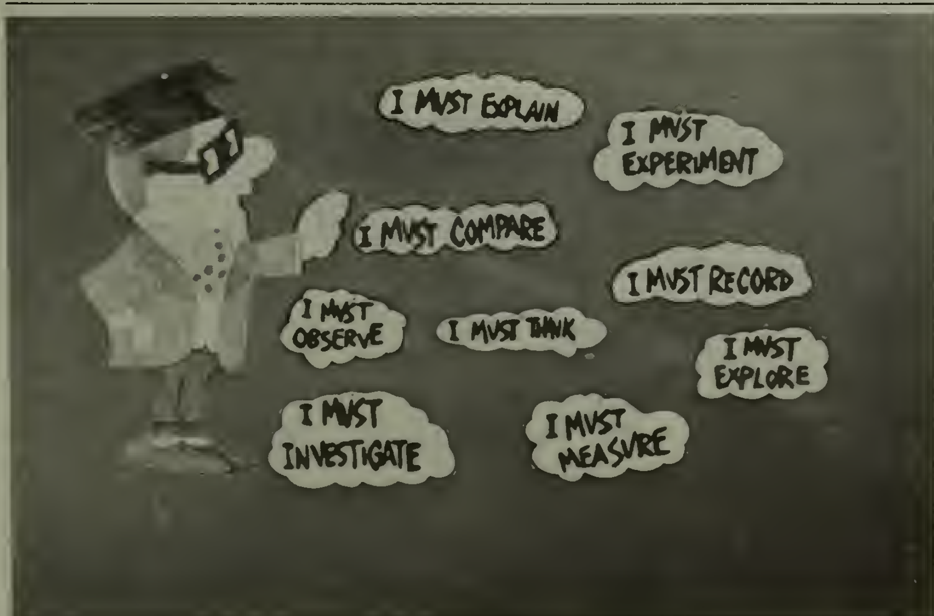
As the child works with a variety of objects and materials, he becomes aware that some objects undergo change, either on their own or as a result of some manipulation or interaction. The ability to observe change and to depict change in descriptive terms is yet another dimension in the process of observing, that of making qualitative observations. Early experiences in making qualitative observations may include observing and describing changes in state of materials (solid to liquid, ice cube to water, etc.), observing and describing changes as a result of burning, dissolving, decomposition, freezing, dehydration, etc. Closely related to qualitative observation is the process of identifying the factor which will or would cause a change, or the expected effect the factor will produce.

An interpretation of an observation is an inference. The teacher should be cautious in distinguishing between observations and inferences. As the child progresses from making observations, the interpretation of observations initiates the development of the skill of inferring. Around grade three the child should be able to distinguish between observations (properties or characteristics perceived by the senses) and inferences (interpretation of the observation). Please refer to the section entitled "INFERENCES" for further clarification.

Proficient skills in observing and inferring lay the basis for the development of predicting skills in upper elementary. A prediction is nothing more than an educated forecast based on prior observation, measurement and inference between related variables. Predicting is further discussed in the section entitled "Predicting". It is important that skills in observing are well developed and established in the primary grades in order that the dependent skill of predicting may develop on a solid base.

The child should be exposed to a variety of experiences in classifying according to:

1. physical properties - colour, size, shape, texture, surface;
2. function - is a food, helps man do work;
3. living and non-living;
4. location or habitat - lives on land, in water, etc.;
5. body parts and their function - has wings, fins, runs, swims, flies;
6. animal, plant, mineral;
7. solids, liquids, gases;
8. interaction with other objects, materials - foams in vinegar, magnetic;
9. predator - prey;
10. sink - float;
11. edible, not edible;
12. other.



Checklist of Observation Skills

1. Identifies properties or characteristics of objects using the five senses.

2. Describes (verbally and in written work) an object on the basis of sensory information.

3. Observes and describes quantitative characteristics of objects.

4. Observes and describes qualitative changes in objects.

5. Distinguished between observations and inferences.

6. Observes and describes objects, change and interaction in objects in the environment.

7. Able to make predictions and inferences on the basis of observation.

MEASURING

Children begin their measuring experiences by comparing length, thickness, mass and capacity of objects. Their measurements are expressed in terms of being "lighter than, heavier than, longer than, shorter than, etc.". These comparative measurements are made by visual examination and physical manipulation of the objects to be compared.

The child should be involved in making estimates or approximations of the size, mass or volume of objects. These estimate experiences occur very early as the child makes comparative judgements by way of physical handling or visual observation, and stating that one object is heavier than another.

The children may then use some arbitrary unit to measure the object being examined. The unit could be in the form of paper clips to measure length or the use of washers as a measure of mass, e.g. the object weight five units (five washers). Since the unit may vary from time to time, the children then discover the need for a standard unit. Initially the student should use the S.I. base units m, l, kg, and later the sub-multiples such as cm, dm, ml and g. At this stage the teacher may elect to have the students construct their own measuring instruments or to use rulers, metre sticks, mass units and equal arm balances found in the school.

The child should also have the opportunity to order objects in sequence from the comparative assessments he has made. The objects may be ordered from tall to low, heavy to light, hot to cold, or vice versa. In addition the child should also order from a relative position. For example, he may be asked to select an object and sequentially order objects from heavy to light. Similar experiences should be provided for capacity, volume, temperature and linear dimension (length, width).

The child should be provided with the opportunity to use a variety of measuring devices (of their own construction or commercially produced) that are appropriate to their level of psychomotor skill. Particularly at the primary level the student should utilize unsophisticated, clearly marked measuring devices.

As the child experiences the use of a variety of measuring instruments, he realizes that a particular instrument with a particular calibration is more suitable in certain situations and impractical in others. When choosing a particular measuring device the student should be able to select instruments with large unit calibrations for large measures and vice versa. It is important that a child experience a variety of calibrations in measuring capacity, volume, mass and linear dimensions.

Because of the base-ten format of the metric units, the student should be able to perceive the mathematical relationship of the sub-multiples (for example, 10 mm = 1 cm, 10 cm = 1 dm, etc.). The ability to mathematically convert measures from one unit to another is not as important as the ability to recognize that each unit may be appropriate in one measuring situation and not in another.

Measuring is a form of data collecting. Initially the child will take measurements of objects immediate to his environment, including

himself. The measurements taken may be for the purpose of describing an object in terms of its dimensions, capacity or mass. Measurements may also be taken to compare and contrast between objects. Measuring is also undertaken to show change in an object, event or situation over time. Such activities as measuring air temperature or measuring the growth of a plant serve as examples of measuring change. Change may be as a result of varying environmental factors (such as light, moisture, temperature), as a result of growth or as a result of one object interacting with another. The child may also introduce change in an object, situation or event as a result of manipulating one variable with another. Subsequent measurements are taken to verify resulting change.

The data or information acquired as a result of measuring must then be organized and communicated in some form or manner. Typically measurements are transcribed into graphs, charts, diagrams, tables, etc. The purpose of such organization is to show possible relationship as a result of some factor of change. The upper elementary student should be able to infer or predict possible relationships, or causes from given measurement data (in the form of graphs, tables, etc.).

The process of measuring is basic to elementary school science. As the child progresses from using a variety of measuring devices and metric units he becomes more skillful in collecting quantified information. This data or information should be as a result of the pupil's participation in some activity-centered experience that is structured by the teaching to arrive at a particular concept or generalization. More explicitly, measuring is a form of activity that is part of an activity-centered lesson.

While many concepts inherent in measurement are part of the elementary mathematics program, science shares in the responsibility when directly applied, for example, in the measuring of plant growth. While the concepts and processes of measuring may be taught separately in math or science, an integrated approach is recommended.

Checklist of Measuring Skills

1. Makes comparative measurements - lighter than, heavier than.
2. Orders on the basis of comparative measurements.
3. Uses arbitrary units (washers, paper clips, swings of a pendulum).
4. Discovers need for standard unit.
5. Constructs simple instruments for measurement.
6. Uses simple instruments for measurement.
7. Able to select appropriate device for measuring.
8. Estimates approximate measure of object.
9. Uses appropriate measuring device with skill.
10. Able to collect data using appropriate measuring device.
11. Able to perform necessary mathematical operations when taking measurements.
12. Able to select appropriate units of measure.
13. Perceives mathematical relationship between the units of measure.
14. Organizes measurement data into communicable forms such as graphs, charts, tables, etc.
15. Makes inferences, predictions from measurement data.

CLASSIFYING

Classification is the process of grouping or organizing objects or events according to common properties or characteristics (such as colour, shape, size, sex, texture, etc.). Classification schemes are used to identify objects or events to show similarities, differences, or interrelationships between objects and events.

Classifying is a very basic process in the development of the child's logical thinking. During the early school years, the child should be provided with a variety of objects (blocks, beads, geometric shapes, etc.) and allowed to sort or group the objects according to size, colour, shape, etc. At first, the activities may be perceived as "plan" with the child suggesting the basis or property for classification. During the period of concrete operation, the child creatively classifies in complex ways. This creativity should be encouraged and fostered. As the child classifies through creative play, he should be encouraged to describe the basis for his classification; for example, all the blocks in this group are red, and the blocks in that group are not red.

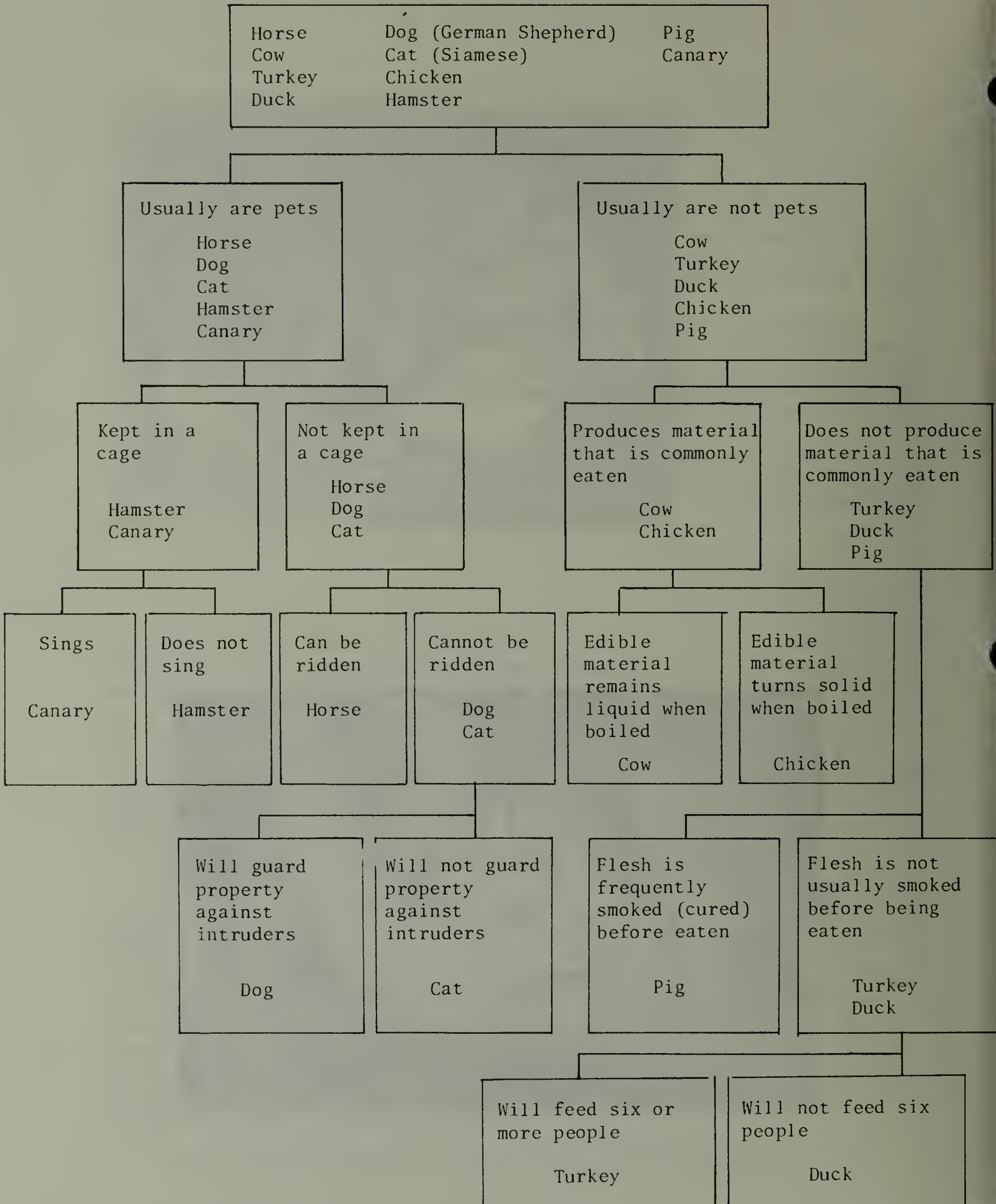
Initially the child will use one property or characteristic to group or sort objects. As his ability to classify develops he will eventually classify according to two properties (all the objects that are red and square - two properties of colour and shape) then three properties and so on. The teacher should carefully plan for the development of the skill to include activities which promote a continuum from simple to more complex classification sets. At first the teacher may direct the classification by suggesting the properties upon which objects are to be classified. While teacher direction is essential and desirable initially, the teacher should allow greater opportunity for children to group upon their self-imposed property.

Later in the development of classifying, the child should be able

to discern or identify the property used in classifying a given set of objects. At this point, the teacher may physically arrange a group of objects in front of the class and ask for the condition underlying the classification. The same result may be achieved through the use of photographs, charts, pictures and diagrams. Classifying games (object is to identify the classification condition) between teacher and students, or students and students provide a motivation in developing the skill. At the conclusion of such activities, the child should describe the basis for his classification.

Classification of objects according to geometric surface and shape integrates very well with geometrical concepts in primary mathematics. The teacher is encouraged to integrate the two subject areas while at the same time bringing out the essence for classifying in both the scientific and mathematical sense.

In the upper elementary grades the teacher may wish to have the pupil express his classification scheme through a diagrammatical format, as illustrated on the following page.



● From Science A Process Approach, Ginn Publishing.

Such activities allow the student to develop constructively a classification according to many stages (properties). Such experiences relate to development of the communication skill through processes other than verbal or written word; in this case, through a diagram. Classification Keys, as illustrated above, may be utilized in refining the pupil's skill even more. Modified "I Spy" games could be played: for example "The animal I have in mind will feed six people, is not prepared in smoked form, what is it?". The students then trace through the classification scheme using the given conditions to identify the particular animal.

The child's ability to classify is clearly influenced by his ability to observe and interpret. As such observing and classifying are very closely related. Another skill which is developed later, but is closely tied to classifying, is "defining operationally". This skill is explained in a latter section of the same title. Classification sets that have been developed as a result of some "action or performed operation" has inherent within it an operational definition. To illustrate the relationship, there may be a classification condition such as "turns powder a blue in an iodine solution, or does not foam in vinegar". The performing of some action to produce an observed outcome for the purpose of classifying is a more complex process and should be left until upper elementary.

<u>Checklist of Classifying Skills</u>

1. Classifies objects according to attributes or properties (colour, shape, size, texture, etc.).

2. Classifies objects first on one property, then two properties and so on.

3. Classifies objects, situations, or events according to given or self-imposed conditions.

4. Identifies the condition or basis of a given classification set.

5. Constructs classification schemes or keys diagrammatically or in some other communicable form.

6. Identifies, through deductive thinking, an unidentified object in a classification scheme given various classification conditions.

7. Applies some form of self-devised classification scheme on any given set of objects, situations or events.

COMMUNICATION

The ability to communicate to others is a process central to all human endeavors. Clear, precise, and comprehensible communication is fundamental to scientific work. Science shares the responsibility, as do other subject areas, of developing communication skills within the child. As such, through a variety of science experiences the child should be given opportunities to communicate orally, in writing, and through the use of pictures, charts, graphs, models and other kinds of audio-visual materials.

Early science experiences in communication should involve students with practice in describing objects in terms of observable properties such as colour, shape, size, texture and hardness. As the child physically

manipulates and visually examines objects, the teacher asks the child to describe the object, insisting that the information be accurate, brief and descriptive. A specific vocabulary of words may be developed which can be used by students when describing various attributes; for example, when describing smell - tart, acrid, or when describing taste - sweet, sour. The vocabulary should consist of words that can be used to describe shape, size, texture, colour, etc. A teacher may also wish to incorporate simple words into the language program.

A test of the given description is to have students try to identify a specific object (from a given set) that has been described by one student. Most children find this fun and enjoy doing it. During such activities, the teacher may observe and note a student's ability to communicate verbally and to test the child's ability to use all the senses in describing his observations.

As the student progresses into making qualitative and quantitative observations, his skills in communication extends. Qualitative observations involve change in an object, through intrinsic or extrinsic forces. As the child identifies and describes evidence of change (difference in properties over time) his need for a sharpened use of words increases. This is more difficult, for children and adults alike, than describing objects that do not change. It is an important skill and requires practice. Initially, qualitative observations are expressed verbally, but should later extend to the written word, to diagrams, pictures, charts, etc.

Quantitative observations require some form of measurement. The result may be comparison of one object to another on the basis "that this object feels heavier than that one". The comparison may be relative to some arbitrary unit as washers or to standard S.I. metric units. Through measurement experiences the student will learn to communicate information through the use of numbers and unit symbols (cm, g, l, etc.). As such, science shares with mathematics common elements of measurement. The Alberta elementary mathematics program introduces standard units of measurement as early as grade two. Quantitative observations may be communicated in verbal form, in written form (writing of unit symbols, dimension of space occupied by an object, etc.) and through the use of charts, maps, etc.

During the K-2 school period, written communication in science should incorporate a sequence as suggested below:

1. Recording responses using simple symbols like (x, ✓).
2. Filling in charts using symbols like (x, ✓).
3. Recording and describing objects or events using simple words.
4. Drawing simple pictures, diagrams, maps.
5. Using number symbols and unit of measurement symbols.
6. Constructing simple pictographs and bar graphs.

As the child matures both physically and mentally, his ability to communicate reaches greater potential or sophistication. In grades three to six, students should become engaged in experiences designed to develop communication skills to greater sophistication and articulation. Characteristically the child should be able to:

1. Describe his own ideas and intuitions in both verbal and written form with greater clarity through an expanded and precise vocabulary.

2. Describe objects, situations and events in written form by way of reports, etc.

3. Use units of measurement and their symbols in communicating quantitative observations.

4. Construct graphs showing interaction of two variables.

5. Devise and construct charts, graphs, tables, maps.

6. Use audio-visual techniques in accentuating the communication process.

Precision and clarity in communication is particularly difficult to develop in the elementary school since children of this age group may not have as yet complete structures for carrying out the process of selection

and analysis. It is important for teachers to consider the child's development and his ability to record and express data in an understandable and organized fashion. The teacher plays a role in illustrating how data can be obtained, organized (charts, tables) and expressed.

While many children are capable of organizing and recording in an precise and neat fashion, other students are not. Neatness is not the main mark of a working scientist. Awarding of marks on the basis of neatness is not supported by what we know about successful procedures in science. The value of the idea, or observation should be of primary concern, with guidance by the teacher to assist the student in his ability to communicate his idea in an understandable way.

Checklist of Communication Skills

1. Describing verbally the observable properties of objects.

2. Describing verbally an object as it undergoes change.

3. Describing in written form (simple words, phrases to sentences, paragraphs, reports) observations.

4. Using simple symbols (like x's, ✓'s) to record responses.

5. Filling in charts using simple symbols.

6. Drawing simple diagrams, pictures, maps and increasing sophistication in upper elementary.

7. Using number symbols.

8. Using written units of measurement and their symbols.

9. Constructing simple pictographs and bar graphs.

10. Extending sophistication in graphing to include histograms, use of coordinate systems, circle graphs.

11. Use of audio-visual techniques in accentuating reports (written and oral).

12. Describes ideas and intuitions with clarity.

INFERRING

An inference is an explanation of an observation. Children begin at an early age to think of reasons for explaining events and happenings that they experience in their day-to-day life. It is important to provide children with learning experiences that are designed to promote clear and logical thinking about their observations; activities aimed at developing the skill inferring serve as an appropriate vehicle in achieving this goal.

Early experiences involving the development of this skill are limited mainly to understanding what an inference is, and recognizing the distinction between inferences and observations. For example, the teacher may hold up a paper bag and ask the children to tell her everything they can about the bag. Responses will likely focus on the colour, size, and shape of the bag - that is, observations made using the sense of sight. The children are reminded that these are observations, and are then asked to guess what is inside the bag. After making several different guesses, the children may see a need to make more observations that involve using other senses. The children are told that their guesses, which are based on several observations, are called inferences. There is a need to provide a large number and wide variety of such experiences in order for children to gain a thorough grasp of the skill inferring, and to be able to distinguish between observation and inferences. As they continue with these activities, the children learn that inferences are always indefinite and that several inferences can be appropriate for certain observations. They learn to report their inferences using terms that reflect this uncertainty - for example, "I <u>think</u> there is a marble in this bag.".

Activities designed to develop this skill further are aimed at assisting children in making inferences that are plausible or supported by every observation that is made. Even though it is not possible to express inferences in terms of absolute certainty, children learn that their inferences are more reliable if they make as many observations as they can. Making more and more observations will often lead children to review and, in some cases, change their original inference in light of this additional information. At this point, the child has developed considerable maturity in terms of this skill - when he is able to test his inference by making additional observations, revise it if necessary, and give valid reasons for choosing a particular inference. Further development of this skill inferring occurs when children show that they are able to perform these tasks even when making observations of objects or events which are unfamiliar.

Having developed skill in inferring, beginning in the lower grades and continuing through to grade six, children should have experiences in the upper elementary grades that offer them a chance to use this skill in a variety of situations. This can be achieved by providing activities that require a child to make an inference that is based on indirect observations. An example of a commonly used activity involves having children infer possible connection paths of hidden electric circuits based on the indirect observation of whether or not connecting a dry cell and lamp circuit to the ends of the hidden circuit will cause the lamp to light up. This type of activity is very useful for showing children that several inferences may be appropriate and equally supported by their observations, although only one of the inferences represents the actual situation.

Whenever feasible, children should record their observations, inferences, tests (additional observations), and reasons for choosing a particular inference.

Checklist of Behaviours for Developing Inferring

1. Make observations using all five senses.

2. Realize that an inference is an explanation of an observation.

3. Distinguish between observations and inferences.

4. Recognize that inferences are, by nature, tentative. Children demonstrate this understanding by wording their statements about inferences using terms such as, "I think it is...", It might be....", etc.

5. Make as many observations as possible, and choose only those inferences that account for all observations made.

6. Test inferences by making more observations, and revise inferences if additional observations do not support the original inference.

7. Make and test inferences when confronted with unfamiliar phenomena.

8. Apply the inferring process to situations which require direct observations.

PREDICTING

A prediction is a forecast of what a future observation will be. It is based on observations, measurements, inferences and involves communicating. A prediction that is not based on observation is a guess.

Predicting is a basic process in the development of the child's logical thinking. During the early school years, the child should be frequently allowed to state his predictions which are based on visual observations and previous knowledge. For example, if a child noted that it was dark at 6:00 p.m. today, he could then predict that it would be dark at approximately 6:00 p.m. tomorrow. The child should communicate his prediction in a manner that gives support to his statement; for example, "Because it was dark at 6:00 p.m. last night, I think it will be dark at about 6:00 p.m. tomorrow".

As his ability to make predictions develops, the child will not only be able to state the expected outcome but also measure and test for the accuracy of these predictions. For example, each student predicts

and measures the beating of his own heart. He will measure and test his prediction with the use of a pendulum. This activity provides the child with the experience of seeing how close his prediction is to the actual measurement.

By continually testing his predictions the child gains skill in determining the reliability of other predictions. Having measured their pulses, the students are now in a position to make predictions about the pulse rate of others. After making these predictions the students test their predictions by measurement.

When a prediction is tested and found to be inaccurate, the child has immediate feedback that should lead him to re-examine the basis for his prediction. For example, students predict mold growth behaviour on various food materials. Such materials as oat flakes, salad oil, bouillon cube, powdered egg, foot powder, dry yeast, powdered milk, fish food, sugar and gelatin are placed in individual containers or hardened gelatin. The students predict which food will yield the most mold growth after three days. After three days they will be able to see the results of the mold growth. The prediction may be altered and a re-test conducted with students identifying and controlling variables (heat, light, dryness, moisture that may have affected results.

Eventually students will be expected to make predictions based on data that has already been proven and recorded. Using Galileo's experiment of falling objects as a reference, the students conduct their own experiment. The students predict what will happen when a flat paper and a paper crumpled into a ball are both dropped from the same height at the same time. Through re-examining and re-testing they will make a new prediction. Many variables will be taken into consideration in the experiment - shape and weight. Papers of identical weight and shape are required. After crumpling, the shape is changed, but the weight is still the same. Therefore it must be the shape that causes the differences in falling time. The students should predict that two crumpled papers, now the same shape and weight, will hit the floor at the same time.

Later, in the development of predicting, the child should be able to make predictions from data recorded in a table, graph, model or map. For example, the students examine weather maps for an area and observe weather changes over four days. By observing the weather maps, the students may infer that the weather proceeded in a particular direction and they may predict the weather on the fifth day.

The student should learn to identify those predictions he can state with confidence and those he has reason to question. This can only be done by testing to see if their prediction is dependable. At first the teacher will provide the test procedure. Eventually, the child will develop his own method of testing and thereby gain confidence in his predictions.

Whenever feasible, all predictions should be recorded and all predictions should be tested.

Checklist of Predicting Skills

1. States a prediction based on past experiences.

2. Measures for accuracy.

3. Tests the results of the prediction:

    a) teacher made;
    b) student constructed tests.

4. Re-tests the results of a previous incorrect prediction.

5. Controls variables that may affect his prediction.

6. Records the prediction and then the outcome of the prediction in symbol or written form.

7. Makes predictions from observing recorded data, i.e. map, graph, model.

8. Able to construct reasonable predictions.

9. Determines the dependability of a prediction.

CONTROLLING VARIABLES

The process of controlling variables is an integral aspect of scientific investigation, and one which many people rely on when solving problems in their daily lives. In any problem or investigation, one can achieve more conclusive results if the variables involved are identified and carefully controlled. A variable can be defined as any factor that may vary or change in an investigation or experiment.

In conducting an investigation, one must try to determine what variables or factors influence or affect the situation, and how this influence takes place. The best way to do this is to keep all variables except one the same, change this variable, and then make observations and/or measurements to what happens. This is controlling variables: some are kept the same or held constant; one variable is changed, and something happens to the other variable as a result. If there is a change in only one variable and an effect is produced on another, then one can reasonably conclude that the effect has been brought about by changing only one variable. If more than one variable changes, it becomes more difficult to say which of the changing variables caused the effect that is observed.

The developmental sequence for this process begins with children recognizing the need to control all variables that may affect the outcome of an investigation. An example of how a teacher may begin to involve children in developing this process skill as early as grade

three follows. An activity might be prepared whereby children try to find out how well plants grow in different kinds of soil. Considerable time would be spent discussing the various factors that affect the growth of plants, and the need to hold all of these factors constant with the exception of the type of soil. The children would then proceed with the investigation and be required to take on the responsibility for ensuring that all variables will be controlled throughout the duration of the investigation. Children will require a large number of such experiences involving a wide variety of situations before they are able to identify all the variables and show how to control them in an investigation. As children go through the grades gaining additional experience in doing investigations in this manner, they should reach the stage where, for any investigation, they will be able to identify variables and demonstrate what will happen when all variables except one are kept the same.

Checklist of Behaviours for Developing the Process Controlling Variables

1. Identify variables that might influence a phenomenon being investigated.

2. Identify which variables should be kept the same and which variables should be changed in an investigation.

3. Design simple investigations in which one variable is changed and all others are kept the same.

4. Demonstrate ways to keep variables constant while changing one variable in a variety of situations.

INTERPRETING DATA

The basic information which comes from observations or measurement seldom leads directly to a full awareness of the situation under study. Inferences or predictions frequently require an organization of the information. The skill of interpreting data requires an ability to organize the data to expose patterns and to recognize valid generalizations that relate the data bits.

Arising from the ability to control the variables in an investigation, the student must have some insight into ways of examining the corresponding observations to reveal trends. A chart or table of measurements, such as the record of time of sunrise as a function of the calendar dates over a few years time, will show a cyclic pattern. The pattern will be clearer, however, if the data points are displayed graphically. Such a graph may provide the student with the grasp of the physical reality of the model we have adopted of the seasons on earth or the apparently arbitrary

division of time we call a year. A clearer understanding may come from an alternative organization that relates the hours of sunlight to calendar dates.

For the student who can anticipate the value of alternative ways of looking at his information and deriving greater insight into the fundamental relationships that are operating, we can say the skill of data interpretation is more highly developed. Out of this insight may come inspiration leading to improved inferences or more valid predictions, or of further tests operating with other variables that will provide more reliable generalizations.

Charts or tables of data seldom provide the clear image of underlying relationships. A graph or histogram drawn from the data provides a visual interpretation without requiring the use of the symbolism of number systems. Graphing, however, requires an ability to select meaningful scale values. This is important both for interpretation and for communicating relationships to others. A line graph may be perfectly valid for showing how the time of swing of a pendulum changes with its length, while a histogram (or graph) is the more appropriate representation of the data.

Skill in data interpretation requires that the student can distinguish between observations that are relevant and those which are extraneous. In addition, it is important to recognize bits of data that, because they do not seem to fit a reasonable pattern, may indicate an error in observation rather than an anomaly in the pattern.

Checklist

1. Recording observations.

2. Organizing observations meaningfully using:

   a) tables;
   b) charts;
   c) graphs.

3. Identifying patterns.

4. Extracting useful information.

5. Generalizing from the patterns.

DEFINING OPERATIONALLY

The ability to communicate, using precise terms in a way that assures complete understanding by others, is vitally important in all human endeavors, and, in particular, when describing scientific investigations. The elementary science program offers children an excellent opportunity to acquire this ability since much of what children do in science class is conducive to developing skill in defining operationally. An operational definition is simply a statement that tells us "what is done" and "what is observed" when describing an object or event. Developing competence in using operational definitions provides children with an extremely useful aid in communication. It may initially appear to be a rather complex skill, but this is not the case if we remember that the development of this process, especially in the early stages, should generally take place in the context of the child's experiences and using language that he and his classmates understand.

In beginning to develop this process, which should normally start in earnest at about grade four, children should be given operational definitions that are related to the activities that are taking place in science classes. For example, for a class that has been using dry cells, wire and lamps to explore different ways of making a closed circuit, the teacher may write these two definitions of a closed circuit on the chalkboard:

1. A closed circuit is a path which carries an electric current.
2. A closed circuit exists when wires are connected to a dry cell and a lamp in a way that causes the lamp to turn on.

Through discussion, the children will see that the second definition is more helpful than the first because it indicates what is done (the wires

are connected to the dry cell and lamp) and what is observed (the lamp turns on). The children are told that a definition which indicates what is done and what is observed is an operational definition. These are distinguished from other definitions which do not provide the two components mentioned, but which, nonetheless, may be correct definitions.

It is necessary for children to be given considerable experience in identifying operational definitions from a list that is provided by the teacher. However, it is also recommended that at the earliest possible stage children should be given the opportunity to begin to make their own operational definitions. To the child an operational definition can only be stated in terms of concrete activities that he has done, using words, ideas, and skills that he has mastered.

Once children have developed competence in identifying operational definitions, it remains for the teacher to make use of the many opportunities which will occur in almost every investigation or activity to give children continuing practice in writing their own operational definitions. Discussions should always focus on "what is done" and "what is observed". As children continue to develop this skill through experience, they will encounter more complex terms which need to be defined and they will also see a need to examine some of their previous definitions, and revise them if necessary, in the light of new experiences and information.

Checklist of Behaviours for Developing the Process Defining Operationally

1. Identify an operational definition from a list.

2. Distinguish between operational definitions and non-operational definitions.

3. Write an operational definition of an object or event for which the child has had direct experience.

4. Write more than one operational definition from a given object or event.

FORMULATING HYPOTHESES

An hypothesis is a possible but tentative explanation to account for one or more observations one has made of a situation. It serves as a starting point for further observations or more serious investigations which might be called experiments. Out of the observation that the sunlight was not as bright as expected, one might hypothesize either that there was some cloud cover or that there was a partial eclipse of the sun. If this was a sufficiently strong stimulus to inquire further, the validity of the hypothesis could be checked with a single simple observation. By contrast, if an observation revealed that a portion of the

lawn under a tree was not growing as well as that farther from the tree one might guess the cause was from lack of water, lack of sunshine, some inhibiting product dripping from the tree or a combination of any or all of these. From the hypothesis comes guidance as to the variables involved in the operation of the system and possible suggestions for means of controlling the variables in pursuing an answer to the question or problem. It may prove that none of the suggested explanations is valid and another factor may need to be introduced - perhaps a parasite or disease is affecting the growth or a burrowing insect or rodent is destroying the plant roots. Honest inquiry does not permit the investigator to adjust the observations simply to avoid the need to discard an hypothesis.

Experience and success in formulating and testing hypotheses, compiled with a rich background of knowledge, tends to improve the quality of further hypotheses and success in testing them. As a way of making good use of more basic skills, such as observing, classifying, measuring, and the integrated processes of inferring, predicting, controlling variables and interpreting data, this higher order skill serves a valuable role in helping the student refine the basics. An hypothesis may be found to be unsatisfactory, not for itself alone, but because it was based on poor observations, careless measurement or improper inferences or interpretation of observations.

Checklist

1. Demonstrates ability to make serious guesses or explanations regarding observations of an event or situation.

2. Assimilates information and assesses the value of the information.

3. Considers and examines critically all possible explanations.

4. Identifies influencing variables.

5. Constructs testable hypothesis.

FORMULATING MODELS

A scientific model is a mental image or an idea of a real system to which a person attributes certain parts or properties that he/she cannot observe directly. This model supplies a possible explanation of how the system works, though it may not provide an accurate description of what really occurs in the system. Generally, the model is simpler than the real system it represents.

Scientific models can be described in terms of pictures, diagrams, mathematical formulae, analogy, three dimensional reproductions, words,

or a combination of these. Scientific models allow students to relate their present observations to previous experiences with similar systems. Children need to think in concrete terms and the use of models helps satisfy this need. Models may also lead to predictions and new discoveries of the system being examined.

Most students in grades 4-6 are able to formulate and use scientific models in very simple situations, but few students are highly skilled. Students will develop models according to their interest, ability, and experimental background and may vary substantially in their formulation and evaluation. On many occasions more than one model may explain the students' observations equally well. Under these circumstances, all models are acceptable until some are proved inaccurate by additional observations, information or experimentation. Since children's ideas have a tendency to complement one another, it is suggested that groups of students evaluate the models considered for class discussion. When the faulty models have been revised, those that are successful will be held with greater confidence by the children. Children who get satisfaction from evaluating and revising their models give signs of scientific maturity and skill in analytic thinking.

EXPERIMENTING

Experimenting is the process of synthesizing all the knowledge and thoughts available to test the usefulness of an hypothesis. It requires the experimenter to recognize a problem and to limit carefully the extent to which it is to be attacked before proceeding further. Appropriate and reliable information, either from observation, or from other sources, must be brought to bear in clearly identifying an approach to test the hypothesis.

Answers to questions subjected to testing by experimentation are of two types. A well-phrased question - a carefully controlled experiment - should provide an answer which can be easily interpreted as "yes" or "no". Poor control of variables leads to a nonsense question and brings back a nonsense answer. It comes down to carrying out an investigation to answer the question: "Is my hypothesis valid in this situation?". The proper interpretation of the observations should tell us whether it is valid or not. It may instead indicate that some part of the experimental procedure or the interpretation of the data will not reveal a clear answer.

Experimenting should begin with a well-phrased question which leads to the formulation of hypotheses that can be tested in carefully controlled experiments. For example: Observation of the puddles that form under the school swings may cause the student to wonder if this is the result of some difference in the soil structure under the swings. The

hypothesis might be that the larger soil particles in which water would settle have been scraped away by the dragging feet. The test would be to compare, by sifting through sieves, the particle sizes of a sample taken from under the swing with that taken from a few meters away. If the hypothesis suggested that the soil was more tightly packed where so many feet had pressed it down, the student could pack the soil together in a neighbouring area and test its ability to absorb water.

Checklist for Evaluating Skill Development in Experimenting

1. Student observes carefully and recognizes anomalies.

2. Ability to relate observations to prior knowledge.

3. Skill in identifying possible variables.

4. Skill in controlling variables.

APPENDIX II

ORGANIZATION OF MATERIALS

ORGANIZATION BY KITS

Where the school science program makes use of commercially available kits, it is advised that schools establish procedures for maintaining these kits in their original form. This can be facilitated by listing all of the items required for that kit on an "inventory" card. This card should indicate the names of each item required in the unit and the quantities of each item required. It should also provide additional spaces to indicate the present number of each item in the kit. Following is an example of the way an inventory card might be set up for the Science: A Process Approach unit Module 43, "A Plant Part That Grows".

INVENTORY CARD						
Module 43 - A Plant Part That Grows			Date and Quantity on Hand			
Quantity	Description	Source	Sept. 1980	Jan. 1981	Feb. 1981	
2	Aluminum pie pans	Grocery store	2	2	2	
48	Flower pots, small	Department store	48	33	48	
30	Copies graph paper	Duplicate in school	30	0	30	
50	Paste sticks	Delta*	50	48	48	
1	Picture card, Strawberry plant	Delta	1	1	1	
5	Plastic trays	Delta	5	5	5	
1 package	Toothpicks	Grocery store	1	1	1	
4L	Vermiculite	Department store	4	1	4	
1	Module 43 Instruction Booklet	Delta	1	1	1	

* Delta is the name of a supplier that stocks S.A.P.A. materials.

The kit should be reinventoried each time a teacher completes the unit. Replacement items should be ordered or purchased well before the next use of the kit. The programs E.S.S., SCIS, SAPA, Houghton Mifflin and STEM (Addison-Wesley) each have commercial suppliers of expendable items. However, for many items, local suppliers can be found that can provide the items more quickly and often at a lower price.

In some school systems, locally developed kits may be established to accompany some units (including some units which are themselves locally developed). Where these units are taught, it is advisable that the kits also be maintained using an inventory card and re-order system.

ORGANIZING COMMON STORAGE AREAS

Most schools have found it helpful to store and organize science materials in some form of common storage area. This area may be a science room or it may be a storage room set aside for science materials. Even in schools where most of the science materials are found in kits, there are a great many non-kit supplies which need to be organized to be used effectively.

In many schools the common storage area for science reflects a variety of programs taught over a long period of time. Often there is an accumulation of items that few of the staff are familiar with and no one knows for sure whether some of the items are worth keeping. In

other schools, especially where there is one person on staff with a strong interest in science, the science room may be well organized with all items easy to locate. If the present organization of materials is working well it should be continued; otherwise a school staff should consider re-organizing the materials using one of the four approaches described below:

1. Organization by Topics

   e.g. - Animal Care Materials
   - Plant Care Materials
   - Containers
   - Microscopes and Magnifiers
   - Metric Materials

   In this method of organization, the storage area is divided into ten to twenty topic areas. Each topic area is clearly labelled. Shelf spaces for some key individual items within each area are also labelled.

   This method of organization has been found to be generally successful and is described in more detail later in this section.

2. Organization by Alphabetical Order

   In this method all shelves bear labels for items listed alphabetically. This method is initially simple to set up but leads to several

complications later on:

i) addition of a new item may necessitate a lot of re-labelling;
ii) sometimes it is difficult to know where to locate an item (e.g. Should a miniature light bulb be filed under "m" for miniature or "l" for light or "b" for bulb?).
iii) materials for any one topic are found spread around the room.

3. Organization by Grade Level

In this method all shelves and cupboards are assigned to individual teachers or grade levels. Each teacher gathers and maintains his/her own stock of materials. This method can work well but it requires a great deal of duplication of supplies and is wasteful of space.

4. Organization by Index

In this method each shelf is labelled with a combination of letters and numbers. Items are placed on these shelves wherever there is a convenient open space. Locating specific items is accomplished by means of an index: either a card index or a large wall chart.

e.g. Shelf List

aluminum foil	A1
alcohol burners	D4
aquariums	G3, G4
asbestos pads	D5

Before any reorganization of materials is attempted, a clear decision should be made by the staff as to which of these approaches (or another approach) is to be followed. It is perhaps not so important which method of organization is chosen as it is important that one is chosen and that the decision is implemented cooperatively by all concerned. Of the four methods of organization described, the topical organization method is the one which usually best suits school needs.

For schools choosing to follow this topical approach, the following detailed topical organization is recommended.

Basic Science Room Organization (A suggested organization of materials by topics)

Containers

These are best kept in open storage for easy accessibility and close to the sink to simplify cleaning up.

- buckets
- pans
- trays
- jars, large
- jars, small
- cans
- vials
- test tubes
- petri dishes
- beakers, plastic
- graduated cylinders
- beakers, pyrex
- bowls
- funnels
- cups, plastic or paper
- saucers
- lids

Construction Materials

- flat boards
- "sticks" (long thin pieces of wood)
- cardboard
- pegboard pieces
- nails
- nuts and bolts
- screws
- dowels
- pieces of metal
- screening
- pieces of glass or plexiglass
- cardboard boxes

Heat and Temperature Supplies

- thermometers
- thermometer reading charts
- candles
- alcohol lamps
- ring stands
- clamps
- hot plate
- bull and ring
- asbestos pads
- convection apparatus
- tongs

Sound Materials

- tuning forks
- bells

Electricity Materials

- batteries (dry cells)
- battery holders
- wire (store as 30 cm lengths of cut wire or hand wound coils of 5 metres length)
- switches
- miniature sockets
- miniature bulbs
- doorbells
- electric motors

Light

- light sources
- lamps
- mirrors
- lenses

Magnifiers

- hand lenses
- micro boxes
- microscopes
- slides
- cover slips

Closed storage for security.

Metric (Mass and Length)

- balances
- masses
- spring scales
- measuring tapes
- trundle wheel
- clinometer
- metre sticks
- metric rulers

Tools

These may be best in closed storage for security.

- hammer
- screwdrivers
- saw
- drill and bits
- clamps
- sanding block
- sandpaper
- files
- knives
- dissecting tools

General Supplies — Most of these items are best placed in drawers or trays.

- straws
- tape
- toothpicks
- eye droppers
- stir sticks and splints
- pipe cleaners
- balls
- spoons
- rubber bands
- scissors
- corks
- stoppers
- wax paper, plastic wrap and aluminum foil
- balloons
- cotton batten
- thread, string and yarn
- rope
- bags, plastic
- bags, paper
- crayons, pencils, felt pens
- filter paper
- labels
- tubing, plastic
- pins, tacks and paper clips

Safety Equipment — Stored in an easily accessable area.

- goggles
- fire extinguisher
- first aid kit
- fire blanket
- eyewash bottle

Cleaning Supplies — Usually placed in a cupboard under the sink.

- sponges
- rags
- brushes
- steel wool
- detergent

Outdoor Study Materials

- soil thermometers
- trundle wheels
- sampling net
- soil auger
- compasses (orienteering type)
- clinometer
- soil sieves

Animal Care Materials

- cages
- water bottles
- food dishes
- litter
- feed
- incubators
- terraria
- ant nest or wormery

Plant Materials

- seeds
- flower pots or cups
- soil
- sand
- vermiculite
- peat
- fertilizers
- stakes for plants

Aquariums and Supplies

- aquaria
- canopies
- gravel
- pumps
- filters
- food
- water test kit
- water treatment chemicals
- brine shrimp eggs
- aquarium air tubing
- nets
- plastic plants

Most of these are best kept in closed storage as they tend to look messy on open shelves.

Minerals and Rocks

- rock sets
- mineral sets
- individual rocks or minerals
- "museum" specimens

Magnetism Materials

- magnets
- iron filings
- compasses (do not store immediately adjacent to magnets)

Optional - Headings for Additional Supplies

Machines

- pulleys
- blocks
- levers
- wheel and axles

Weather

- barometer
- thermometer
- weather maps
- rain gauge
- anemometer
- weather record board

School Museum

- bird nests (do not encourage collection of additional specimens)
- wasp nest
- large rock specimens
- oil specimens
- manufacturers display kits
- bones
- models of planes, trains, machines, etc.
- parts of machines
- mounted plants
- insect specimens

Pictures

- animals
- plants
- plant and animal communities
- landforms
- weather
- astronomy (solar system, stars)
- energy and machines
- minerals and rocks
- electricity and magnetism
- light
- sound

APPENDIX III
EQUIPMENT AND FACILITIES LISTS AND INVENTORIES

PURCHASING EQUIPMENT AND MATERIALS

Equipment and/or materials purchases should be made according to the instructional needs of the resource alternative chosen. The equipment and/or materials list available through the publisher should be examined and materials and/or equipment not available in the school should be ordered.

With the exception of the kit program in Alternative Four, the need for specialized items has diminished somewhat. The other resource alternatives have been deliberately designed by the authors to use materials readily available from the home or local commercial outlets. In most cases a "scrounging list" taken home by students will produce much of the needed equipment and materials. It would be wise to consult with local wholesalers and distributors for better buys than may be available through scientific supply houses.

When ordering science materials, priority should be given to ordering class sets, or quantities sufficient for small group work. This enhances the opportunity for maximum participation of students in activities, as opposed to demonstration lessons forced upon the teacher because of the lack of equipment or materials.

When ordering equipment, consideration should also be given to differences in abilities of Division One children and those in Division Two. Division One children require equipment suitable for their large muscle coordination capabilities and, therefore, unsophisticated apparatus with large calibrations is the best. Plastic, unbreakable containers and equipment should also be considered over fragile, expensive and sophisticated items.

Schools should consider the use of an inventory catalogue system which provides a record of current stock, ordered stock, breakage, cost and location in science room and recommended sources of supply.

FACILITIES LIST

A science facility should be designed so there is a maximum amount of flexibility. As programs change, the room can be adapted with a minimum of expense and effort.

The following lists indicate some of the more desirable provisions in a well-planned facility for elementary science instruction.

soil bins (steel or plastic lined)
ventilation fan
acid resistant counter tops
floor sink c/w water outlet
kitchen sink c/w water outlet
test tube/beaker drying rack
rubber mats in wet areas
minimum of eight electrical outlets
growing stations c/w ultraviolet
table top desks or trapezoid tables
locked cupboard space (2 m)
tote tray shelving and tote trays
chart and display boards (4-7 m)
chalkboard (minimum 6 m)
chart hangers
provisions for hanging screen
counters at height of table tops (average 80 cm)
filing cabinet
refridgerator (particularly helpful in support of the life science program)
first-aid kit
fire extinguisher
fire blanket
eye-wash neutralizer
A.V. trolley
safety goggles
dust pan and broom and mop

EQUIPMENT LIST

Following is a basic list of equipment and materials that would normally be found in a well equipped elementary science room. The list is not complete and teachers should consider the particular needs of the program alternative they have chosen as well as this basic list.

aluminum foil
asbestos mats
alcohol burners
aquariums or terrariums (13L , 19L or 38L)
aquarium air pumps
aquarium heaters
aquarium filters
aquarium gravel
aquarium canopies
bags - paper and plastic
balloons - various sizes and shapes
balances
barometer
batteries, D cell and larger
battery holders
beakers, plastic - various sizes and shapes
beakers, pyrex - various sizes and shapes
brushes for cleaning
bowls - various sizes and shapes
buckets
bulbs, miniature, 2.5 volt
buttons - various sizes and shapes

cameras - instant and film
candles
clinometer
clamps of various kinds
compasses, magnetic
cover slips
cylinders - graduated
clamps
cotton batten
cotton balls
cups, clear plastic, paper
measuring
clock, watch, timers, stop-
watches
combs (hard rubber)
carbon paper
compasses
cages - various sizes
clay, modeling
charcoal
copper sheeting
corks
drinking straws
drill and drill bits
doorbell
drying racks
extension cords
emery boards
eyedroppers
funnels
fan (electrical)
filter fibre
fish net
fish food
fishing line
flashlights
flower pots
gloves
globe
graph paper
hammers
hand lenses
hotplate
incubator
iron filings
iodine
ice cube trays
jars - various sizes and shapes
knife - paring, dissecting
knife switches - single pole,
single throw
litmus paper
labels
light sources, light boxes
marbles
matches
mirrors - plastic or metal
microbox magnifiers
microscopes
microscope slides
minerals, various kinds
metre sticks
magnets - bar, horseshoes and
ceramic
pans, aluminum - cake pan size
petri dishes
pipe cleaners
pins, T head, straight, safety
pliers
paraffin
paste
plastic wrap
prisms
protractors
rocks, various kinds
rope
rubber gloves and lab coat
rubber bands
rubber stoppers
ring stands
saw
scissors
screwdrivers
seeds, various kinds
sockets, miniature
soap
specimen jars
spoons, plastic
safety goggles
soil
string
sand
sandpaper
sponges
spring scales
steel wool
straws, plastic
tape, masking, plastic

trays
thermometers, plastic or metal backed
toothpicks
thread
tea kettle, electric
tape measures
tubing, flexible, clear
test tubes
test tube racks
tongs
trays, plastic
vermiculite, potting
vials
waxed paper
water bottles
wire - various kinds and gauges - insulated and uninsulated
yarn
zinc sheet

INVENTORY

A simple inventory system can be useful in determining what supplies need to be re-ordered. For kits, each kit could have its own inventory card. (See page 139 for a sample card.)

For items placed in common storage, each item could be listed on a separate card similar to the sample shown below. These cards could then be maintained in a file from which they can be pulled when re-ordering of supplies is needed.

Science Inventory Card

Item: Candles, birthday — Source: Co-op Store
Normal Stock: 4 boxes (48 candles)
Location: Room 107, Cupboard 22

Date	On Hand	Ordered	Purchased or Received	Remarks
80-09-03	43			60¢ per box
81-01-26	20	3 boxes		
81-03-08	56		36	New price 72¢/box

For convenience in setting up such a card system, the sample cards shown on the following page could be duplicated and used by the school as masters for its own inventory cards.

Science Inventory Card

Item: ______________________________

Normal Stock: ______________________________

Location: ______________________________

Source: ______________________________

____

Date	On Hand	Ordered	Purchased or Received	Remarks

Science Inventory Card

Item: ______________________________

Normal Stock: ______________________________

Location: ______________________________

Source: ______________________________

____

Date	On Hand	Ordered	Purchased or Received	Remarks

Once it has been determined what needs to be ordered or purchased, lists should be made of the items needed, one list for each supplier. When the items are ordered from a scientific supply house, the order could be typed from a rough order drawn up on a page such as the following. (Duplicate this page as needed.)

BUDGET FORM

Name of Supplier ______________________ Date Ordered ____________

Address of Supplier ____________________ Ordered by ____________

______________________________________ Course No. ____________

Page No.	Catalogue No.	Description of Item	Quantity	Price	Extension

APPENDIX IV
SAFETY PROCEDURES AND GUIDELINES

On the following pages, a number of basic safety guidelines are described. However, it should be kept in mind that no set of safety rules can be complete. The best guide for most situations is the common sense of children and teachers.

HANDLING OF ANIMALS AND PLANTS

Keeping animals in the classroom for study and for handling can be a valuable asset to the science program. To ensure the health and safety of both students and study animals, the following guidelines are suggested.

1. The teacher should check whether students have allergies before bringing animals into the classroom. This can usually be done by simply asking the children whether they have allergies, but for younger children it is wise to either check their medical records or send a note home advising the parents of the animals to be kept.

   In case of a mild allergy, it may be possible to maintain the animal in the classroom but not allow the child to handle it. For more

serious allergies, the animal may have to be kept somewhere other than the regular classroom. In some extreme cases the keeping of animals may have to be ruled out entirely.

2. The animals should be obtained from a known reputable supplier. They should be in good health and of good disposition.

3. No child should be allowed to bring an animal into the classroom without the permission of the teacher.

4. Animals should be kept in suitably sized enclosures which can be easily maintained and cleaned.

5. The animals should be well fed and cared for.

6. If a mammal or bird appears to be in poor health, it should be checked by a veterinarian to identify the problem. Many animal ailments are infectious to humans so if there is any doubt, the animal should be removed from the classroom area until the problem has been identified and corrected. In the event that an infectious ailment is detected, the veterinarian's recommendations should be followed and parents of students who have handled the animal should be advised.

7. Students should be advised regarding safe handling of animals. Note that most animals will bite if handled roughly or if handled at an inopportune time (e.g. hamsters are not at all friendly when they have just awakened or when food is taken away from them). Caution students that too much handling by too many students may be stressful for the animal. Hands should be washed after handling animals.

8. An animal which bites should not be kept in the classroom. If an animal has bitten a student sufficiently hard to break the skin, the student's parents should be advised. As a normal precaution, the student who was bitten should receive a tetanus shot if he has not recently had one.

9. An animal should be kept in the classroom only so long as it is a meaningful part of the program. An animal that is being neglected is both a health hazard and a negative learning experience for the children.

Suitable Classroom Study Animals

Mammals

- rabbit
- guinea pig
- hamster
- gerbil
- mouse

Birds	baby chicks (for short periods) baby ducks (for short periods) budgerigars canaries pigeons doves
Reptiles	chameleons small snakes
Amphibians	aquatic frogs newts tadpoles hatched from frog eggs
Fish	goldfish guppies tropical fish
Insects	aphids mealworm beetles ladybird beetles (ladybugs) caterpillars fruit flies milkweed bugs
Crustaceans	isopods crayfish tree crabs
Worms	earthworm
Pond Water Organisms	gamerus fairy shrimp

Animals That Should Not Be Kept

No native species of wild animal or bird should be kept in the classroom. To do so would create an unwarranted source of possible infection. In most cases the keeping of these mammals or birds is also unlawful (for details, see the Alberta Wildlife Act or contact your local wildlife office).

Plants In The Classroom

Just as some students may be allergic to particular types of animals, students may also be allergic to certain types of plants (e.g. some students may be allergic to fuzzy leafed plants such as African Violets). The teacher should identify any such allergic reactions and eliminate using these as classroom plants.

Teachers of younger children should also be aware that some plant leaves are poisonous (e.g. Dieffenbachia).

HANDLING HEAT SOURCES

Each of the program alternatives recommended in this guide includes at least one activity that involves the use of a flame. The flame may be produced by a candle or alcohol burner and, in at least one program, bits of wood and coal are burned. In order to minimize the dangers during these activities, the following guidelines are recommended:

1. The burners (candles) should be set on a level table or desk, not on a sloping surface.

2. If a candle is used, a non-flammable tray or pad should be placed underneath.

3. Emergency equipment should be placed at several convenient locations in the classroom (e.g. buckets of water, fire extinguisher, or fire blanket).

4. The teacher should conduct a classroom discussion on safety concerns. This discussion might focus on the following questions:

   i) What things in the room could catch fire? (e.g. hair, clothes and paper are especially flammable.)
   ii) What things could happen that might lead to an accidental fire being set? (e.g. student's hair dangling in a flame, horseplay or showing off. Be sure to point out that accidents are usually caused by unforeseen combinations of events rather than by bad intentions.)
   iii) What does a fire need to continue burning? (Elicit that a fire needs three things: a fuel, air (oxygen) and heat. If any one of these three is removed, the fire will go out.)
   iv) What should be done in case of an emergency? (Ensure that students know where the emergency equipment in the classroom is located and what is to be done with it. It may be helpful to simulate an emergency and have students act out their responses.)

5. Before working near a flame, students with long hair should tie their hair back. Unnecessary flammable materials should be removed from the area.

6. If students are to light the flames themselves, the teacher should discuss and demonstrate the safe use of matches.

Note that electrical fires and fires involving flammable liquids involve additional dangers. Both of these types of fire require special treatment.

Electrical fires involve the added danger of electrocution. If possible when an electrical fire is discovered, the electrical current should be turned off at the source. Unless this can be done it is dangerous to use a water type fire extinguisher. A carbon dioxide type of fire extinguisher or foam type fire extinguisher should be used.

Fires involving flammable liquids may be spread further by use of conventional fire extinguishers. If the quantity of chemicals being used is large, a carbon dioxide fire extinguisher or other type of class B fire extinguisher should be used.

HANDLING OF ELECTRICAL DEVICES

Electrical devices are potentially dangerous in two ways: (i) they can cause electrical shock; (ii) they can cause fires. These are dangers that are present with most of the electrical equipment we use, but when used properly, the dangers are minimal. Some guidelines for the safe use of electricity in the elementary science classroom are as follows:

1. All student learning activities with electricity should make use of batteries as power sources rather than domestic household current. As a general guideline, elementary students should not handle electrical sources capable of producing more than 12 volts. This guideline is consistent with the four programs in this guide each of which recommend the use of 1½ volt batteries (dry cells).

2. Students should be advised that although their classroom activities with electricity are safe, any experimenting with household current is extremely dangerous.

3. Students should be taught the safe handling of classroom electrical equipment such as tape recorders and record players. In particular, students should be taught how to safely insert or remove a wall plug.

4. All classroom electrical equipment operating on domestic electrical current should be marked C.S.A. approved.

5. Where an electrical device has a triple (grounded) plug it should not be connected by means of an extension cord which has only two wires (ungrounded).

6. Students should be cautioned never to handle electrical equipment when their hands or feet are wet.

HANDLING CHEMICALS

It is not necessary for elementary schools to maintain large stocks of a wide variety of chemicals. Following are lists of chemicals which may be required for one or more of the elementary science program alternatives. Quantities of these materials should be purchased only as required and stored in their original containers. (Any chemical materials found in unmarked containers should be disposed of in an acceptable manner.)

PART 1

Required Chemicals Suitable for Open Storage
(Access by students acceptable with teacher supervision)

	Addison-Wesley S.T.E.M.	Doubleday Exploring Science	Houghton Mifflin SCIENCE	Alternative 4 Programs
Bicarbonate of Soda (Baking Soda, $NaHCO_3$)	x	x	x	x
Borax			x	
Citric acid				x
Corn starch	x			
Corn syrup			x	x
Detergent (powdered)	x			
Epsom salt	x			x
Food coloring	x		x	x
Gelatin				x
Oil, cooking	x		x	x
Petroleum jelly	x			
Salt (NaCl)	x	x	x	x
Seltzer tablets			x	
Sugar (sucrose)	x		x	
Vinegar	x		x	x
Yeast	x			x

PART 2

Required Chemicals for Secure Storage
(Access by teachers only)

	Addison-Wesley S.T.E.M.	Doubleday Exploring Science	Houghton Mifflin SCIENCE	Alternative 4 Programs
Alcohol, methyl				x
Alcohol, rubbing			x	
Alcohol, isopropyl				x
Ammonia (household strength)		x		x
Ammonium chloride				x
Bromothymol blue	x		x	x
Calcium hydroxide				x
Calcium carbonate		x		x
Chlorine bleach			x	x
Cobalt chloride				x
Congo red				x
Copper chloride			x	x
Copper sulfate				x
Fertilizer		x	x	x
* Freon 11 or Freon 12				x
Glycerine				x
Incense	x	x		
* Iodine crystals				x

*Not recommended

	Addison-Wesley S.T.E.M.	Doubleday Exploring Science	Houghton Mifflin SCIENCE	Alternative 4 Programs
Iodine, lugols or iodine, tincture	x		x	
Laundry blueing		x		
Limewater		x		
Litmus paper			x	x
Magnesium sulfate				x
Magnesium ribbon				x
Oil, mineral			x	
Oil, household or automotive	x		x	
Plaster of paris	x		x	
Pyrogallol				x
Salol (phenyl salicylate)			x	
Scouring powder	x			x
Silicon				x
Sodium sulfate		x		
Sodium theosulfate				x
Sodium hydroxide solution				x
Tes-tape	x			

DANGEROUS CHEMICALS

Additional chemicals for activities not recommended in this guide may be used at the discretion of the experienced teacher. However, the following chemicals are specifically identified as dangerous and should not be used.

DO NOT USE	Mercury	
	Ether	
	Carbon tetrachloride	
	Carbon disulfide	
	Strong acids or alkalis (bases)	
	Sodium or potassium metals	
	Phosphorous	
	Strong oxidizers such as:	Potassium nitrate
		Potassium peroxide
		Potassium cholorate

These chemicals should be maintained in secure storage only as long as necessary until they can be disposed of in a safe manner.

HANDLING GLASSWARE

1. Glass tubing should not be used in student activities due to dangers of breakages and cuts.

   Note that none of the programs in this guide makes reference to glass tubing. The use of plastic or metal tubing is recommended for those activities where glass tubing may previously have been used.

2. Only pyrex glassware should be heated.

3. All chipped or cracked glassware should be discarded.

4. Where practical, plastic containers should be used in place of glass ones.

APPENDIX V
CONTROVERSIAL ISSUES POLICY STATEMENT

In August, 1972, The Minister of Education announced a policy regarding controversial issues. This announcement was in response to representations having been made regarding the treatment in school programs of such matters as Canadian content, family life education, sex-stereotyping and special creation, to name a few. By way of interpretation the policy is to be treated as a whole: that is, no clause is to be applied in isolation of any other clause or clauses. The policy is intended to accomplish the following in the handling of issues such as those mentioned above.

1. Provincially it will:

   a) guide the development and revision of Programs of Study, including the acquisition of support materials.
   b) serve as the Department of Education position in cases in which the Department may be consulted regarding controversial issues.

2. Locally, the statement is to serve as a guide for the development of policy at system, district or school levels, according to local choice.

DEPARTMENT OF EDUCATION
Re: CONTROVERSIAL ISSUES IN THE CLASSROOM

I. In principle, it is an objective of the Alberta educational system to develop students' capacities to think clearly, reason logically, examine all issues and reach sound judgements.

II. The specific policy, based on this principle, is:

   1. Students in Alberta classrooms should not be ridiculed or embarrassed for positions which they hold on any issue, a requirement which calls for sensitivity on the part of teachers, students and other participants in dealing with such issues.

   2. Students should have experiences in selecting and organizing information in order to draw intelligent conclusions from it. For sound judgements to be made, information regarding controversial issues should:

      a) represent alternative points of view,
      b) appropriately reflect the maturity, capabilities and educational needs of the students and reflect the requirements of the course as stated in the Program of Studies,

c) reflect the neighborhood and community in which the school is located, but not to the exclusion of provincial, national and international contexts.

3. School trustees should establish, in consultation with appropriate interest groups, policies regarding:

   a) identification of controversial issues,
   b) treatment of such issues in local classrooms.

4. Students, teachers and administrative staff should have a voice in determining:

   a) the controversial issues to be studied,
   b) the texts and other materials to be used,
   c) the manner in which such issues are dealt with in the classroom.

In response to representations regarding the treatment of the theory of evolution in school science programs, the Science Curriculum Co-ordinating Committee prepared and presented the following policy statement to the Curriculum Policies Board. This statement, which interprets the Department's policy regarding controversial issues in relation to science programs in the classroom, was considered by the Curriculum Policies Board in March, 1979, and was accepted by the Minister of Education in June, 1979.

a) That where relevant, official curriculum documents published by Alberta Education for use by science teachers should contain:

i) the Department of Education policy statement on controversial issues.

ii) a special statement alerting teachers to the need for sensitivity in handling such issues.

iii) a listing of available learning resources from which school boards, teachers, and/or students may select items representing alternative points of view on such controversial issues as may be included in a Program of Studies.

b) That, at the provincial level, all science curriculum committees and/or individuals associated with selecting, recommending, listing and/or prescribing texts and/or other learning resources for use in Alberta schools be directed to:

i) confine their choice to those learning resources in which the science subject matter is deemed to be satisfactory in

terms of the definition of science:

Natural Science is a branch of knowledge obtained by the scientific method, which deals with a body of observable and reproducible facts concerning material phenomena, systematically arranged and showing the operation of general laws and theories.

ii) *select learning resources that are satisfactory in terms of scientific accuracy, adequacy of treatment, and reading level.*

iii) *recommend the development of such additional materials as may be deemed necessary. (To be used only as a last resort.)*

c) *That, in the initial selection stage, the inclusion or exclusion of science subject matter in Alberta school science curricula be determined by validating it according to the definition of 'Natural Science' in (b), (i) above.*